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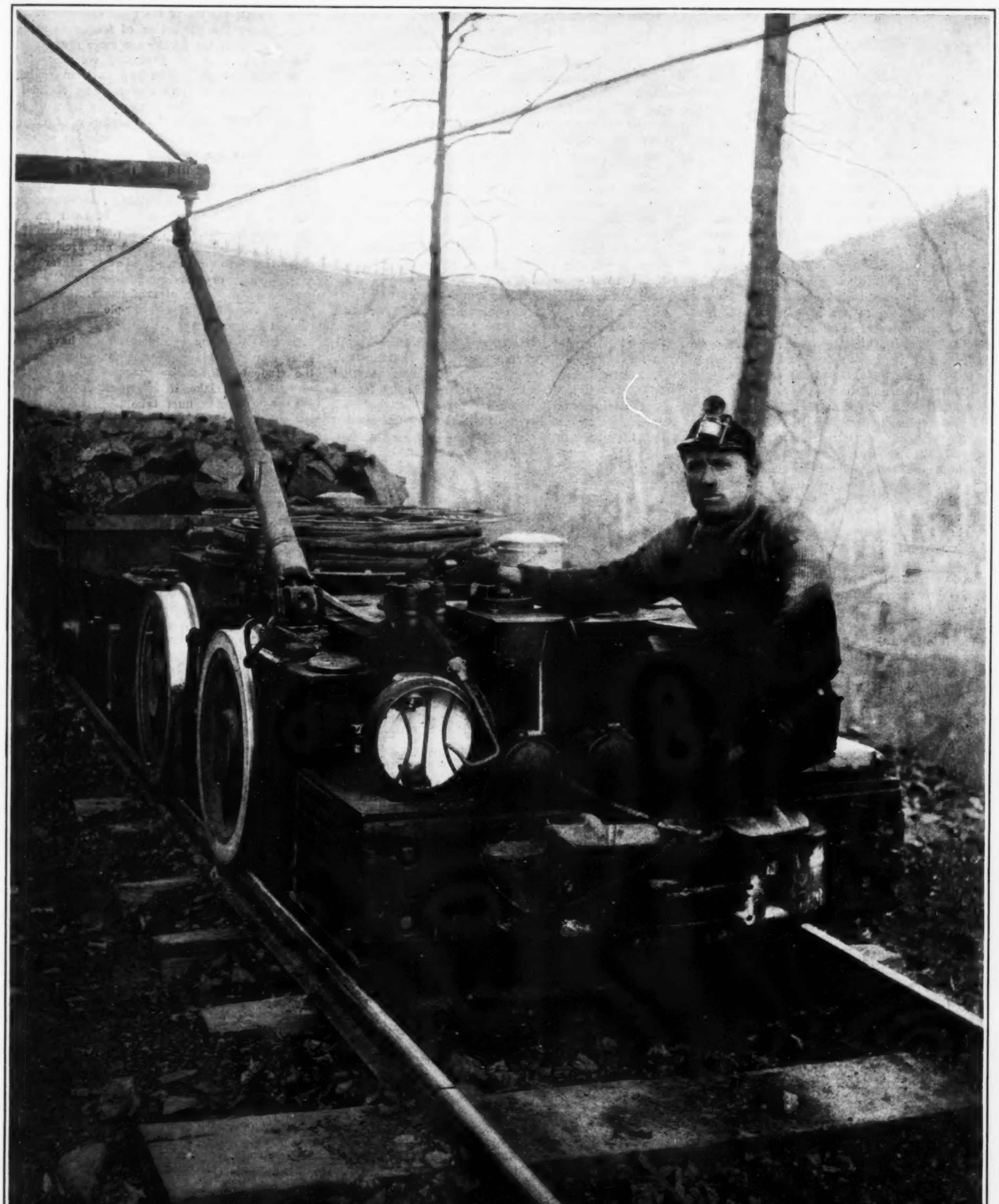

A type of modern electric locomotive used for hauling coal from the mines

SCENES AT THE COAL MINES—[See page 72]

The Pleionian Cycle of Climatic Fluctuations*

A Study Equally as Important as Normal Conditions

By Henryk Arctowski

As we observe changes of weather from one day to another, so we observe climatic fluctuations from one season to another, from one year to the following year. Persistency of given weather conditions may frequently be observed. In the case of climatic fluctuations, also, there may be a series of years abnormally dry or abnormally rainy, or we may have groups of years offering some other particularities such as a late spring for example, or an unusually warm winter, and such exceptional conditions, recurring for a succession of years, give the impression of a radical change of climate.

In reality, therefore, we may consider the study of these changes or fluctuations just as important and as having a far more practical value than the study of the so-called normal climatic conditions.

Considering ten-yearly means of atmospheric temperature as representing quasi-normal values, I inscribed the annual departures from these means on maps. For each year so far taken into consideration the departures are never positive all over the world, or negative; in each case some regions are characterized by an excess of heat, whereas in other regions temperature is in deficiency. The areas of positive departures have been called thermo-pleions and those of negative departures anti-pleions. The anti-pleions do not necessarily compensate the thermo-pleions. The year 1900, for example, was a year of an excess of pleions and the year 1893 was a year of deficiency of pleions. The difference of the world's temperature, for such exceptional pleionian and anti-pleionian years, may reach 0.5 degrees C. or perhaps even more.

Taking barometric measurements into consideration, one also finds that for each year some centers of abnormally high and abnormally low atmospheric pressure are conspicuous.[1] These baro-pleions and anti-baros displace themselves from year to year, and evidently influence atmospheric circulation very greatly.

These changes must have an effect on the distribution of storm frequency[2] and on rainfall. Of rainfall data, I have studied extensively the ombro-pleions observed in Europe during the years 1851-1905, but the results of these researches have not been published.

In order to investigate these phenomena more thoroughly, the monthly means of temperature, atmospheric pressure, rainfall, sunshine duration and thunderstorm frequency have been taken into consideration and the changes from one year to another have been studied by the method of overlapping means.

Among other results it was found that at many stations, particularly in equatorial regions, temperature rises or falls practically simultaneously and that the pleions disappear and reappear more or less periodically at intervals of 2 to 3 years.[3] The records of the Harvard Observatory station at Arequipa, in Peru, have been taken as a standard of the occurring pleionian fluctuations,[4] and the results of the comparisons made induced me to search for the cause of this cycle of climatic variations.

After it was demonstrated that the cause of the formation of pleions could not be attributed to the presence or absence of volcanic dust-veils in the higher levels of the atmosphere,[5] it was but natural to search for their origin in the variations of the solar atmosphere.

It seems obvious that, if changes in the vertical circulation of the incandescent solar clouds exist, these changes must produce oscillations of the quantity of thermal energy radiated into space.

A few words of explanation are necessary.

Although it is difficult to imagine how the heat of the solar atmosphere originates, or where it originates, we must admit that the amount of heat is greater below the incandescent photospheric clouds than above,—simply because these clouds are a phenomenon of condensation, due to loss of heat, and because condensation could not take place if the temperature below the clouds was not higher than the temperature above. In consequence, we must admit that, just as in the case of terrestrial atmospheric conditions, the radiation into space, from below, must be a question of cloudiness. This radiation is not necessarily constant. If the vertical currents producing the ascending clouds are intensified, the loss of heat must be greater. For the sake of comparison, our terrestrial Cu-Ni clouds, with their panaches of false-cirri, may serve as an example.

I imagined that the solar-faculæ, which always accompany the formation of sunspots, might have an origin similar to the false-cirri, and this vague analogy led to the supposition that perhaps the faculæ would give some information concerning possible changes of the intensity of the output of solar energy. Faculæ are indeed merely a product of the solar atmospheric circulation. Faculæ occur often independently of sunspots, but more often they accompany the spots. Some connection exists also between the frequency of spots and the formation of faculæ. When sunspots are numerous, larger areas of the solar surface are occupied by faculæ. For the average characteristic outbursts of sunspots, the accompanying faculæ reach their maximal development about nine days after the spottedness has reached its maximum.[6] The faculæ are evidently one of the phases of the phenomenon that produces the formation of spots.

Admitting that a sunspot is the center of violent descending currents in the solar atmosphere, we must admit that the vapors slide sidewise from the spot when they reach the lower levels and reascend, at a certain distance from the spot, more quietly and overheated. It is to these ascending currents that the formation of faculæ must be ascribed. Faculæ must, therefore, radiate into space a quantity of heat larger than the quantity of heat radiated by the spotted area. If so, the ratio of the surfaces occupied by faculæ and sunspots must equal or be proportional to the ratio of radiation.

If, therefore, the pleionian cycle of terrestrial temperature is to be ascribed to solar fluctuations, we may presume that the quotient of the areas of faculæ and sunspots is not constant, and we may suppose that the changes of this quotient vary in harmony with the pleionian cycle. And the fact is, that not only this ratio of faculæ and spots varies extensively, but also that these variations present some striking similarities with the Arequipa or standard type of thermo-pleionian fluctuations.

The figures I have utilized[7] are those of the Greenwich photo-heliographic measurements. In order to eliminate the shorter fluctuations, and to obtain numbers comparable to annual means of temperature, I have formed the totals of the areas of umbræ and faculæ for every consecutive solar 10 rotations. I have used the figures given for the rotations 275 to 805, or the results of the measurements made during the years 1875 to 1913. Then I divided the faculæ numbers by those for umbræ. The quotients thus obtained express numerically how many times the areas of faculæ exceeded those of umbræ. The curve representing these figures graphically, compared with the curve of sunspots, shows an unmistakable correlation with the 11-year period. The curve may indeed be characterized as follows:

Well-pronounced minima preceding by approximately 12 rotations (or more or less 9 months) those of spots; less pronounced minima coinciding or preceding by a few rotations the maxima of sunspots; then, in each 11 years' cycle, another minimum between the minimum and maximum of the curve of sunspots and two minima between the maximum and the following minimum. And so, in the period of more or less 11 years' duration there are 5 maxima of the ratio of faculæ and umbræ; the first coincides with, or closely follows, the minimum of spots, the second occurs between the minimum and the maximum and the three others occur between the maximum and the minimum of the sunspot curve.

It may be useful to mention that the range of these variations is well pronounced. The highest observed ratio of 10 consecutive rotations is 73.74, while the lowest figure is 2.42. But these are extreme values. The average ratie of the 15 observed crests is 26.93 and the mean of the corresponding depressions is 11.47, or less than one-half. Such are the facts.

To come back to hypothethical considerations, it may be asked how these fluctuations of the ratio of faculæ and sunspots can be explained?

Let us say that the depth to which our terrestrial storms extend is limited by the surface of the earth crust or the surface of the sea. Evidently the sun does not present similar conditions and *à priori* we may admit the possibility of variations in the depth to which the circulation of the solar atmosphere may extend. If so, the proportion of faculæ to spots must vary, and when the faculæ are more predominant, we may suppose that the ascending columns of vapors come from greater depths and that, in consequence, the radiation is increased. Some sort of tidal movements making the solar atmosphere more or less expanded would explain the possibility of changes of depth to which the vertical circulation extends.

Now, since the maxima of solar faculæ—umbræ ratios reoccur—just like the terrestrial thermo-pleions, ombro-, helio- and baro-pleions,—at intervals of 2 to 3 years, and since some striking time coincidences exist, I shall call these maxima of solar fluctuations, horme-pleions,—which simply means pleionian impulses.

I say expressly horme- and not arche-pleions, because this last name must be reserved for the solar, or planetary, or cosmical relations which cause the changes of the solar atmospheric vertical circulation, changes for which the horme-pleions are simply numerical expressions.

In the foregoing considerations I have spoken of solar clouds. This expression may displease some of the students of solar phenomena. But what difference does it make if condensation of calcium for example can or cannot take place at the very high temperatures of the photosphere? For my considerations it is absolutely indifferent if the faculæ are formed of incandescent dust or of metallic vapors condensed into liquid drops or whether they are simply gaseous vapors.

Again, another objection may be raised against the conception of the circulation in and around the solar spots that I have adopted. But in this case also, theory has no importance since the fact is that umbræ radiate less heat than the average photospheric surface and that faculæ seem to radiate more heat.

Speaking of heat, it would also be preferable to aviod that expression entirely and use the words radiation, or energy, or radiant energy of the sun.

But all such objections have nothing in common with the fact of the existence of a horme-pleionian variation, a fact which is a result of the Greenwich measurements and of my calculations. And now, in order to establish a theory of the terrestrial pleionian fluctuations, more calculations are necessary.

The first effort to be made is to find out whether atmospheric temperature varies proportionally to the ratio of the faculæ and umbræ, or, if such a law cannot be established, because of the complexity of meteorological phenomena, it will be necesary to show at least some striking correlations between the variations of one and the other. Up to the present, a lack of time has prevented me from making more than one single attempt, which has been successful, and I wish to show now how the horme-pleionian maximum of the solar rotations 772-781 found its repercussion in the temperatures observed on our earth-surface during the years 1911 and 1912.

In order to have figures corresponding exactly to the same time-intervals as those of temperature, monthly means of the areas of faculæ and umbræ were calculated, for the years 1909 to 1913, and then the ratios of the overlapping yearly totals were formed.

These figures expressed graphically on a diagram show a well-pronounced crest of the horme-pleion corresponding to the mean of June 1911 to May 1912. But before this maximum is reached we notice two steps, one at the mean of April 1910 to March 1911, and the other corresponding to the mean of November 1910 to October 1911. In 1912 the ratios decrease till a minimum corresponding to the mean of March 1912 to February 1913 is reached, and from then on the ratios again increase and form the ascending branch of a new horme-pleion. To simplify comparisons, we may call 1911:2 the mean of February 1911 to January 1912; 1911:3 that of March 1911 to February 1912, and so forth. The figures for 1910:4,—1910:11,—1911:6 and 1912:3 are therefore conspicuous.

For the same years 1909-1913 I have prepared more than 150 curves of overlapping temperature means of stations from all parts of the world. This amount of

*An address before the Second Pan-American Scientific Congress. From the Am. Jour. of Science.

[1] Bull. Amer. Geogr. Soc., v. xlii, p. 270, 1910.

[2] Month. Wealth. Rev., v. xliii, p. 379, 1915.

[3] Annals N. Y. Acad. Sc., v. xxiv, p. 39, 1914.

[4] Bull. Am. Geogr. Soc., v. xliv, p. 598, 1912.

[5] Annals N. Y. Acad. Sc., v. xxvi, p. 149, 1915.

[6] Mem. Soc. Spettr. Ital., Ser. II, vol. iv, p. 181, 1915.

[7] Ibid, p. 185, 1915.

already computed data is very respectable, but of course I am anxious to obtain more data, and I do not think that the difficulties one encounters in collecting the results of meteorological observations made in some countries or the shocking mistakes that may be found in the tabulations of official publications of some other countries, will prevent me from trying to make my research as thorough as possible.

If my reasoning is correct, it follows that at the time of the occurrence of the horme-pleionian maximum of 1911:6, or shortly afterwards, we should observe thermo-pleionian crests on the curves of overlapping means of the observed temperatures. Or, since it has been found that in no case studied so far, temperature was above the average all over the world, that, on the contrary, anti-pleions always compensate the pleions, more or less, it will be necessary to find at least a predominance of thermo-pleions synchronal with the solar maximum.

And so it seems to be.

Of the records studied so far I may say that an abnormal increase of temperature during the latter part of 1911 and 1912 is a striking feature of the curves of meteorological stations in Alaska, British Columbia, Vancouver Isl., Oregon, and, to a certain extent, California, then of Mexico, Panama, the West Indies and Bahamas, British and French Guiana, Matto Grosso, Parana, Peru,—the Füroë Isls., Holland, Northern Germany, Switzerland, Italy, Gibraltar,—Algeria, Morocco, the Canary Isls., the Sahara, Egypt, Senegambia, the French Congo, the Transvaal,—Aden, Quetta, India, Ceylon, Mauritius and Seychelles Isls., the Strait Settlements, Cochinchina, China, Japan, Eastern Siberia,—Australia, and the Touamotou Isl. in the Pacific.

The records of a certain number of stations show a retarded pleionian effect. I will cite those of Greenland, Iceland, Carolina, Florida, Cuba,—the Caucasus and Russia,—Southern Nigeria, Togo, German South Africa, Madagascar,—Palestine, Mesopotamia, some stations of India, Christmas Isl., the Philippines, and New Caledonia. Even in the Antarctic regions the records of Cape Evans station, under 77° 38′ S. lat., show that during the months of May to September, or during the South polar winter, the mean temperature in 1912 was 10° F. higher than in 1911.

In striking contrast with these results most stations of the United States, as well as Wellington and Auckland in New Zealand, and some stations in Russia, show a well pronounced depression of temperature corresponding in time with the occurrence of the horme-pleion and the greatest development of thermo-pleionian conditions in so many countries in different parts of the world.

The American anti-pleion is of particular interest, because of the pleions observed in the Northwestern states, Alaska, Canada and Greenland, as well as in the Southeastern states, the West Indies and Mexico. In North America temperature conditions were evidently in conformity with the horme-pleion, except in the greatest part of the central portion of the continent. Moreover, it was precisely at the time of occurrence of the horme-pleionian maximum, or soon afterwards, that the greatest lowering of temperature was observed in the Middle West from North Dakota down to Texas.

Evidently the supposition that these abnormally low temperatures were due to the veil of volcanic dust produced by the Katmai eruption of June 6th, 1912, is completely out of the question. If that had been the case, temperature would have decreased from that date on, whereas it was decreasing for more than a year before that date in order to reach the minimum at the time of the occurrence of the horme-pleionian maximum and accidentally at the time of the Katmai eruption. The conclusion to be drawn from these facts is that the American anti-pleion of 1911-1912, corresponding in time with practically universally observed pleionian conditions, must have been mechanically produced by abnormal pressure distribution and the resulting abnormal winds. In other words, it seems most probable to me that the anti-pleion observed in the United States was simply due to changes of atmospheric circulation due to the exceptionally well-developed pleionian conditions in the North as well as in the South of the States. The same must have been the case of the other anti-pleions in New Zealand and in Russia, and perhaps in some other countries. But precisely because these anti-pleions are to be considered as an effect of dynamical reaction against the predominant pleionian conditions, it is evident that they could not compensate the action of the horme-pleion.

The direct effect of fluctuations of solar activity upon atmospheric temperature can also be observed in some of the details of the horme-pleionian crest. The steps of the ascending branch, corresponding to the means 1910:4 and 1910:11, as well as the minimum of 1912:3, may easily be distinguished on many of the overlapping temperature curves. But even in more minute details some of the curves present such similarities with the solar curve, that a simple chance circumstance can hardly be presumed, and that forcibly, we must admit that the cause of these temperature fluctuations is really a question of ratio between solar faculæ and umbræ.

Poultry Culture

Indian Game

Every breed of poultry has its attraction, whether the requirements are utility or fancy, and it is satisfactory to find that, notwithstanding the increasing demand for variety and utility, many of the oldest breeds still maintain their high position. The Indian or Cornish Game deserves greater prominence, and justly claims to be one of the utilitarian breeds which wisely combine "elegance with substance." With the continual booming of Wyandottes, Orpingtons, Plymouth Rocks, Rhode Island Reds, Sussex, Faverolles, and other breeds, this good old Cornish fowl too often suffers; but, whilst many excellent breeds compete with the Game, few excel it as a producer of massive table fowls for the market. Fanciers have too long favored the table side only, neglecting the laying (and especially winter laying) propensities. The increasing need for combination should no longer be overlooked. The Cornish Game can truly be designated a general purposes breed. With a few years' careful selection (male and female) prolificacy should be ensured, and high fecund strains built up from existing stocks.

The Indian Game Club, whose objects are to increase the popularity of this useful breed and protect its interests, the standard of perfection being drawn up wisely, demanded a very active, upright, sprightly and vigorous carriage. Back sloping towards the tail, flesh firm in handling, with plumage short, hard, lustrous and close. Body shape thick and compact, very broad at shoulders, shoulder butts showing prominently, breast wide, of fair depth, prominent, and well rounded; body well poised on very strong and thick legs, with large thighs, round and stout. Typical specimens should display a veritable "bulldog" type among poultry. Enthusiastic poultry fanciers, whilst striving for excellence, have kept closely to the correct type of ideal table poultry.

Complaints are frequently made of the poor characteristics displayed by fowls sent to market, which reflects most discreditably upon breeders of poultry for the table. Indian Game lend valuable assistance, possessing broad, deep breasts, heavily meated throughout, and capital thighs. Specialist breeders proudly boast that the standard-bred bird carries more flesh (in the right place and where most wanted) than any other fowl. In pre-war days the Palace, Smithfield, and other leading shows penned well-bred specimens of immense width and size, cocks weighing 13 pounds and hens 11 pounds. It may be added there have been few champion winners in table poultry classes that have not possessed some Indian Game blood. Crossed with almost any breed, the progeny is excellent.

To those who demand meat for the table and rich brown eggs in moderation, of good size, together with a hardy breed, suited to heavy clay soils, the Indian Game is recommended. A favorite cross is with the Dorking, which ensures quicker growing chickens, with deep, meaty breasts, large-sized birds, with white legs. Crossed with the Buff Orpington, wonderful birds for consumption can be bred from a young, well-grown cockerel being mated to two-year-old massive hens. The Croad-Langshan is noted for length of breastbone; whilst the Indian Game excels in width, making a splendid cross worthy of farmers' attention. It will certainly pay agriculturists to use Indian Game cockerels and cocks as sires for their mixed flocks for the coming season to improve the general shape and type and insure hardiness.

Those who have not already completed breeding arrangements should lose no time, especially with the heavy breeds of poultry, which take longer to develop than the small, active varieties. The present season should find the poultry breeder full of work and expectancy, and enable him to test the full value of his stock. All houses, appliances and machinery for hatching and rearing should ere now have been disinfected (creosote is advised), overhauled and made ready for immediate use. Those who wish for prolific winter layers must recognize the absolute necessity of early spring hatching in order that pullets may mature for ovarian production during the autumn. Development should be completed by October or November to avoid complaints of shortage of winter eggs.

Methodical working with the seasons is one of the secrets of success in poultry culture, and the poultry-keeper who neglects the favorable season and leaves matters to chance is only courting failure and vexation. It is in such affairs that agriculturists and farmers generally are very apathetic, and consequently suffer financially. They invariably leave the hatching of poultry until midsummer, when broody hens are plentiful, losing most valuable time, besides unpatriotically encouraging the breeding of unprofitable stock. January and February hatched stock are always of considerable value in next season's breeding pen, when fully matured cockerels are required, especially in the heavy breeds.—*London Daily Telegraph.*

Burn Up Garden Trash

Burn Weeds and Rubbish That May Harbor Insects Over Winter

Throughout the United States are plots of ground cultivated last spring and summer as temporary war gardens. Where these plots were suitably located, with due attention to sunlight, abundant crops of vegetables, especially for family use, have been produced, but quite too frequently such plots have become generally neglected, with the result that much material in the form of crop remnants and rank weeds will remain through the winter, favoring during the autumn the continued multiplication of certain forms of insect pests, and during the winter a safe harbor for the insects to pass the colder months. Next spring these insects will reappear, and if the same plots are selected for planting there is grave danger of serious injury, particularly soon after planting.

The methods employed in commercial truck gardens and farms to prevent the wintering-over of insects in the field should be put into practice in case of the war or "back-yard" garden. Entomologists of the United States Department of Agriculture advise that as soon as a crop has been harvested the remnants should be promptly cleared away and burned with the insects which they harbor. The same applies to weeds, including grasses which spring up between the rows. Rubbish of all kinds should be carefully collected and destroyed in the same manner that no shelter be left for the insects during the winter.

Try to induce your neighbors to carry out the same measures; otherwise you may fail.—*Weekly News Letter* of Department of Agriculture.

New Zoological Specimens Found in India

The first annual report of the Zoological Survey of India, a new and promising transformation of the Indian Museum Cinderella, contains a great deal of interesting information. New ground was broken in the Shan States, where the director of the survey, Dr. Annandale, personally superintended a survey of Lake Inlé. The basin of this lake is stated to have been formed by solution, in limestone rock, and to be filling up with silt and aquatic vegetation; the water is shallow and of extraordinary limpidity; floating islands are a notable feature; fishes of many new species were discovered, for three of which new generic definitions are necessary, among them a minute eel so peculiar as to require seclusion in a new family; the molluscs are scarcely less remarkable, and among them occurred a group of pond-snails interesting not only for the bizarre shape and bright color of their shells, but also because an almost complete series of forms transitional between them and nearly normal forms was found in other parts of the lake, in other neighboring waters, and fossil in the surrounding country. Mr. Kemp, superintendent in the survey, investigated the Mutlah channel of the Gangetic delta; this is a deep and permanent channel, and its waters, which are never very salt, are heavily charged with silt; a remarkable feature of its fauna is said to be the extraordinary resemblance of some of its fishes and crustacea to deep-sea forms, in coloring, in gelatinous translucency, and in filamentous feeler-like appendages. Dr. Chaudhuri, an assistant-superintendent in the Survey, paid a visit to certain large tanks in Seringapatam, where a century ago Buchanan-Hamilton obtained several species of fishes that have never since been brought to light; Dr. Chaudhuri was successful in rediscovering some of them. A feature of the report, as an official departmental publication, are the excellent illustrations.—*Nature.*

Anomalies of the Animal World—Part VII.

Due to Artifical Selection and Breeding

By Dr. R. W. Shufeldt

EMUS, or emeus as some spell it, are not high-colored birds like their cousins the cassowaries; on the other hand, they are quite lacking in brilliant plumage. There are but two species of them known, namely the emu of eastern Australia *(Dromaeus novae-hollandiae)*, and the one from the western side of the same continent *(D. irroratus)*, while several fossil species, or the remains of them, have come into the hands of science; these are all from the Pleistocene.

In the emus the wings have almost entirely disappeared, while in general appearance they are shabby-looking birds of dull attire. The male is smaller than the female, and is, for the most part, silent throughout the year. On the other hand, the female has, at certain seasons, a booming note of great power, with others of a more musical character. These are made possible by a peculiar structure which she possesses in the shape of a mebraneous bag connected with the wind pipe. The emus are being rapidly exterminated by man in Australia, and within the next hundred years, or perhaps in a much shorter time, it is not likely that a single living specimen of the emu will be found upon this planet. Men and dogs are responsible for thus exterminating a most interesting bird that, at one time, roamed in thousands over the entire mainland of Australia. Cassowaries and emus are admirable swimmers—a fact not generally known to those who have seen these birds in captivity only. The western emu is known as the Spotted one, and the other species, that is, the one found on the eastern side of the Australian continent, is the Common emu. It is to be hoped that the Australian government will very soon enact some law which may preserve these birds from total extermination. They thrive well on the plains of the interior.

In so far as birds are concerned, some of the oldest fossils, in the matter of time (Miocene), which have fallen into the hands of science, are those representing the great, flightless, fossil avian giants of Patagonia in South America. They belong to the *Phororhacidae*. Judging from such parts of their fossil bones as have been found, they were evidently great terrestrial birds of prey. Some of the species were small, but this is made up for by the others; and in the case of one of them *(Brontornis)*, it had a thigh-bone considerably larger and longer than that of an ox.

Of all the remarkable flightless birds of this group, however, was the giant *Phororhacos;* it must have been over eight feet in height, with a skull bigger than that of a full-grown horse, and much deeper from above downwards. We know little or nothing of these birds or what led to their extinction. With its great, hooked beak and powerful claws of great size, *Phororhacos* must have been a terror to the animals upon which it preyed. Skulls and some other bones of this bird have been discovered.

Another most interesting group of birds are the Kiwis of New Zealand; they belong to the family *Apterygidae*, so named on account of the rudimentary condition of their wings, which are totally useless for the purpose of flight. Their name, Kiwi—or Kiwi-kiwi—has been given them for the note they utter, although they are also widely known by the name of *Apteryx*, especially among naturalists. These birds are all found upon the islands of New Zealand, and some six species of them have been described. Mantell's *Apteryx*, or Kiwi, is here shown in Figure 1, while Owen's *Apteryx* has a shorter bill and a rounder appearance, and is an inhabitant of South Island, N. Z. They are all being rapidly exterminated by man, especially by the resident English, who mercilessly hunt them with dogs; but, as Alfred Newton said, "There is some consolation in the thought that their anatomy and development have been admirably studied and described in the light of existing scientific methods by Prof. T. Jeffrey Parker." The author of this work sent me a presentation copy, and I never glance at it in these days but that the thought comes to mind of the shame it is that so little of its kind is now being published.

Kiwis have great swiftness of foot; when running they extend the neck forward, hold the body obliquely, and make long strides with their strong legs. They possess not a few anatomical peculiarities in their organization—the nostrils situated at the distal extremity of their long upper bill being among these; and while hunting for their food, which consists largely of worms, which they skillfully draw from the soft ground with their beaks, they make a peculiar and continual sniffing sound. They have been kept and studied in captivity on numerous occasions in zoölogical parks and gardens. None of the species exceed a large fowl in size, and some are rather smaller.

These birds are in no way especially related to the ostriches, as some naturalists claim, while Sharpe placed them in an order by themselves, the *Apterygiformes*, not being confused by characters they possess in common with not a few still surviving ancient types.

Fig. 1.—Mantell's Kiwi

We now pass to a consideration of another group of flightless birds, in which the wings are not only present, but have become greatly modified to subserve another purpose. These are the penguins, of which there are a number of genera and species existing, as well as fossils of others which have been found (Patagonia, Miocene, etc.). As to their habitats, penguins are all confined to the southern hemisphere, being chiefly found on the islands of the Antarctic Seas, New Zealand, Australia, the Falklands, Kerguelen Islands, Galapagos, coasts of Brazil, Peru, Chile, South Africa, and elsewhere. There is no doubt but that the ancestors of the existing penguins were birds fully endowed with the power of flight, while the wings of those now existing resemble the "paddles" of a cetacean more than the wings of a bird. They are quill-less and incapable of flexure except at the shoulder joint. With these a penguin can swim under water with all the grace and rapidity of a seal, catching fish with equal alacrity. Their short legs are not much used in swimming; but on shore they hop about with them with considerable adroitness, some of them being called "rock-hoppers" (Fig. 2). These several habits confine them strictly to seaside resorts, and on certain shores, rocky and otherwise, they occur in numbers. Their plumage is of a scale-like character, quite different from true feathers, and their entire anatomy is most interesting. In some localities tens of thousands of them form a "rookery," where they breed and rear their young.

Fig. 2.—Rock-hopper Penguin. By the author after G. W. Wilson & Co.

In one of the *Challenger Reports* Professor Mosely thus describes his exeperience at once of these rookeries: "At first you try to avoid the nests, but soon find that impossible; then, maddened almost by pain (for they bite furiously at the legs), stench, and noise, you have recourse to brutality. Thump, thump, goes your stick, and at each blow down goes a bird. Thud, thud, you hear from the men behind you as they kick the birds right and left off the nests; and so you go for a bit—thump, smash, whack, thud, 'caa, caa, urr, urr,' and the path behind you is strewn with the dead and dying and bleeding. Of course, it is horribly cruel to kill whole families of innocent birds, but it is absolutely necessary. One must cross the rookeries in order to explore the island at all, and collect the plants, or survey the coasts from the heights."

It seems to me that altogether too much cruelty was exhibited upon this occasion, or, as Prof. Alfred Newton said, such incidents are disgusting.

Of all the penguins the Emperor Penguin is the largest, being nearly as big as the King Penguin of the Kerguelen Islands, the former often attaining a height of three and a half feet, and may weigh as much as eighty pounds. In this Part two portraits of penguins are presented, the first being a "rock-hopper," also called "macaronis" by sailors, a form representing the crested penguins (*Catarrhactes*, Fig. 2), and the King Penguin (Fig. 3), of which there are two species *(Aptenodytes forsteri* and *A. patagonica)*. There is also the Gentle Penguin, or "Johnny" *(Pygoscelis papua)* of the Kerguelen Island, of which one of the naturalists on the British Transit of Venus Expedition wrote (Kerguelen Island, 1874-5): "The whole of this community of Penguins was subsequently boiled down into 'hare soup' for the officers of the H. H. S. Volage." It would seem that a better class of officers should be selected to accompany scientific expeditions.

Black-footed penguins *(Spehenicus demersus)* are found in South Africa, and Humboldt's penguin *(S. humboldti)* on the coasts of Peru and Chili; there are a number of others, the smallest species of all being the blue penguin of South Australia and New Zealand, which attains a height of only seventeen inches.

Among all the wanton butcheries of birds that have horrified thoughtful and refined people, none can exceed those which have occurred upon a number of the penguin rookeries, where, on certain occasions, men have slain these helpless creatures by the thousands.

Through popular and scientific writings, the Great Auk has come to be so well known that a passing word will be sufficient to call attention to the fact that this one-time famous as well as flightless sea-fowl of the North Atlantic seas became extinct along about the year 1844. In Figure 4 of this article we have an illustration of him, it being a reproduction of an india-ink drawing of mine, which originally appeared in *Century Magazine* (1884) as one of the illustrations to my article on "Feathered Forms of Other Days." We still have in our avifauna the Razor-bill Auk, which, though smaller than the extinct Great Auk, is very much like it in plumage and form, notwithstanding the fact that its wings exhibit no reduction whatever, the species enjoying the fullest possible powers of flight.

Considerably less than a century ago there must have been several thousand Great Auks living on Funk Island, where they bred in large numbers. As usual, man soon exterminated them; and now an egg in good condition will fetch $1,200; a museum skin of one of the birds will bring, perhaps, nearly as much. There can be no question that the Great Auk is descended from a species closely resembling it, but in which the wings were fully developed and capable of sustaining the bird in strong flight. Possibly that ancestor was smaller than the Great Auk, which was about the size of an average goose, though there is nothing to base such an opinion upon. Prehistoric ancestors of exist-

Fig. 4.—The great Auk. By the author

ing birds are usually found to be much larger than the latter, though there are probably numerous exceptions to this rule.

A few years ago there was discovered on Narborough Island, one of the Galopagos group, a large, flightless cormorant *(Nannopterum harrisi)* that has since been described by the Hon. Walter Rothschild in the "Novitates Zoologicæ" of the Tring Museum. His description is accompanied by a colored plate of a pair of the birds; this was photographically copied by me, and a reproduction of the photograph is given in Figure 5 of this article. This great, dark green Cormorant, with its much reduced, and, for the purposes of flight, powerless wings, is known as Harris' Cormorant, and there can be but little doubt but that it, too, will eventually be exterminated. Recently I prepared an illustrated account of its skeleton; and it is interesting to note, as the wings in this species became more and more reduced from one generation to another, how this reduction was accompanied by a relative increase in the size and strength of the bones of the legs, as well as in the main median bones of the trunk skeleton, apart from the breast bone and shoulder girdle. These last having attached to them the principal muscles employed in flight, they, too, exhibit very marked atrophy in some of their parts. These birds, as those from which they are descended, gradually became flightless for the simple reason that they were living under conditions where flight was of no special advantage; at the same time, to be powerful swimmers was the all-important thing for them, enabling them to catch with ease their finny prey, which lived in the sea where Narborough Island is found. Extinct or existing, this is the only known cormorant that happens to be flightless, the majority of the latter enjoying that power to a very full extent.

One of the most interesting, as well as extraordinary instances of the loss of flight in birds is to be seen in the "Steamer Duck" *(Tachyeres cinereus)*, which occurs in the Straits of Magellan, the Falklands, and off the coasts of Chile. This duck, when young (Fig. 6), enjoys excellent powers of flight; but when adult it becomes quite incapable of flying, though it gains remarkable speed as a swimmer (Fig. 7). It is said that its movements while swimming suggested the action of a side-wheel steamer. At all stages of its existence this duck is a very beautiful representative of its family, and excellent illustrations of it are presented in the "Mission Scientifique du Cap Horn" (1882-83), in the section Birds, by E. Oustalet. (Plates 4 and 5, colored.) These I have copied and they are reproduced as illustration to this article (Figs. 6 and 7). For some time ornithologists believed these to be different species.

Stock-Killing Animals*

Take Heavy Toll from Nation's Food Supply

A SINGLE wolf in Colorado took a toll of nearly $3,000 worth of cattle in one year; in Texas, two wolves killed 72 sheep, valued at $9 each, during a period of

Weekly News Letter of Department of Agriculture.

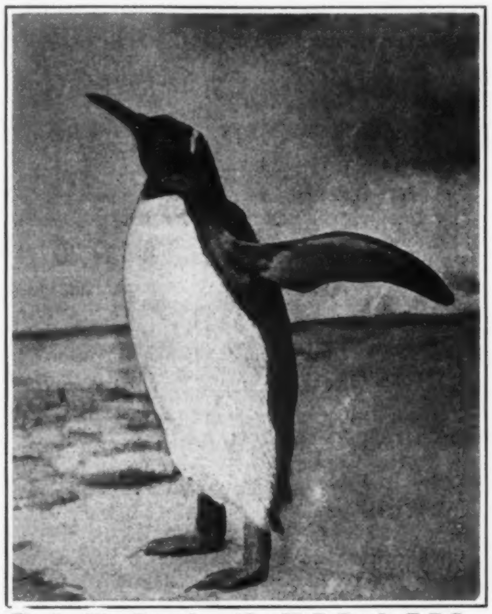

Fig. 3.—King Peuguin. After W. P. Dando, F. Z. S.

two weeks; in Oregon, four coyotes in two nights killed 15 pure-bred rams valued at $20 each; and one bobcat in New Mexico in one month killed 53 lambs, one ewe, and one goat belonging to a single ranchman. These points are brought out in the report on the work of the Bureau of Biological Survey of the United States Department of Agriculture for the fiscal year ended June 30, 1917.

The destruction of such stock-killing animals has a direct bearing on the increased production and conser-

Fig. 6.—Steamer Duck (Subadult). By the author after Oustalet

Fig. 7.—Steamer Duck (Adult). By the author after Oustalet

Fig. 5.—Harris' Cormorant. By the author after Rothschild

vation of the nation's food supply. Their control means that stock and poultry raising can be conducted with safety, and with this in view the bureau employs a force of 175 to 300 hunters and trappers who hunt these animals. They accept no bounties from any source, all skins of animals taken becoming the property of the Government. Last year the proceeds from this source amounted to approximately $36,000.

OVER 100,000 PREDATORY ANIMALS KILLED.

During the year 30,512 predatory animals were taken, including 556 wolves, 22,342 coyotes, 107 mountain lions, 3,053 bobcats, and 60 bears. Bears are generally considered game animals and are not molested by the predatory-animal hunters except in cases of individuals known to have the habit of killing stock. In addition to the capture of animals by means of traps and shooting, extensive poisoning campaigns were conducted, and it is conservatively estimated that at least 75,000 predatory animals were destroyed in this manner.

As a result of this destruction of stock-killing animals a large saving of cattle, sheep, goats, horses, swine, and poultry has been effected.

The Bread Problem in the West Indies

THE West Indian colonies, in common with the rest of the world, have their bread problem. How this is to be met is the subject of an official inquiry, and an interim report of British Guiana Flour Substitutes Committee, published in the Bulletin of the Department of Agriculture, Trinidad and Tobago (vol. xvi., part 2), indicates the lines upon which action can be most usefully taken. Analyses collated by the committee show that the products of tropical origin which most nearly approach wheat flour in food value are rice, guinea-corn, and maize. These materials can be employed alone only in the preparation of cakes. Without wheat flour they do not give a satisfactory bread. Other products of relatively higher starch content which are of local origin, *e. g.*, cassava, sweet potatoes, tannias, and eddoes, can also be employed in this way, but they yield an article of lower food value and wider nutrient ratio. It is possible, however, by the addition of a proportion of meal, obtainable from locally grown pulses, *e. g.*, pigeon-peas, black-eye peas, lima, and bonavist beans, to bring the nutrient ratio of these more starchy products up to the desired standard. Action upon these lines is recommended, and a proposal is put forward for the establishment of a factory, or factories, for converting the locally grown raw materials into non-perishable and marketable products.—*Nature.*

Cats and Game

THE cat because of its destruction of game birds and small game is beginning to figure in the statutes. Massachusetts in 1917 passed a law prohibiting possession of cats on Meskegat Island or the bringing of any cats to the island and Michigan declared cats following on the track of game birds or small game public nuisances an decreed that the owner who permits them to run at large after notice from the game commissioner shall be deemed guilty of a misdemeanor.—*Weekly News Letter* of the Department of Agriculture.

Electric Vehicle Performance in Winter*

Cold-Weather Reduction of Battery Capacity May Be Largely Overcome

By Kennedy Rutherford

THROUGH many adverse conditions and numerous objections that have to some extent been overcome, the electric vehicle for both pleasure and commercial applications has come to stay. The central-station companies and their affiliated societies are largely to be credited for the rapid growth of these vehicles within the last few years, and in applying them to many applications now known to be extremely suitable that once were thought far beyond their sphere of performance.

The high initial cost of the electric vehicle, as compared with the gasoline vehicle, and public bias have been factors to be overcome. The dependence of the vehicle for performance upon the capacity of a storage battery, the scarcity of charging stations, and delays and cost incident to a discharged battery have also contributed in hindering the use of the electric vehicle upon a wider scale. However, the increasing number of electrics in use has enabled these difficulties to be largely overcome by the springing up of charging stations and a practical battery exchange system, while the high initial cost, in Chicago at least, has been removed as a barrier to their use by the co-operative system inaugurated this year by the local central-station company.

The large central-station companies have long appreciated the latent possibilities of the electric vehicle as a load builder, that is at once a revenue producer and a means of bringing in a part of the overhead charges upon the generating and distributing systems, since the load is one that comes on chiefly during the night. The result is that the central-station companies have made strenuous effort in the development of the electric vehicle, with what success is now beginning to make itself apparent.

But while the manufacturer of vehicles and the company that hopes to supply them with energy can and have accomplished wonders in bringing the electric vehicle to the high state of efficiency and adaptability it has attained today, the individual owner can himself do much in bettering the performance of his vehicles. There are a few matters that have come to the writer's notice through experience, often exasperating and sometimes almost disheartening, that to his knowledge have not as yet been covered in the technical press. Some of them hold promise of great returns in the way of better performance, and for this reason the writer wishes to give them publicity for the general good.

INFLUENCE OF WEATHER UPON ELECTRIC-VEHICLE PERFORMANCE

The performance of any mechanically propelled vehicle tends to become less satisfactory in winter than in summer. In the fall the roads become wet and slippery, ruts and mud holes form which interfere with the movement over the road. In the winter the earth freezes, perhaps snow falls to block the way, or the roadway becomes very slippery, decreasing maximum acceleration and tractive effort. Even where the roadway is smooth and frozen hard, thus being favorable for high speed, the cold air decreases the efficiency of the vehicle by increasing journal friction. Both gasoline and electric vehicles suffer during the winter months because of the condition of the roads. Actually the gasoline vehicles suffer more than the electric, because the characteristics of the latter—high sustained gradually applied torque—are more favorable to it, but on the other hand in obtaining these characteristics the battery becomes discharged, thus necessitating the electric being hauled home or else creeping along like some wounded thing.

In the large cities that boast of good roads, while the main thoroughfares may be maintained in first-class condition, many of the outlying roads in the residential districts and off the main paths of travel become almost impassable after the fall and spring rains. It is along these roads that the large army of delivery trucks, coal and ice trucks make their daily tour. It is in these outlying territories that most of the difficulties occur due to mud holes and deep ruts, and it is likewise in these same that help is most difficult and expensive to obtain.

When an electric vehicle sinks into a deep hole several things may happen. In endeavoring to get out the smooth-tired wheels churn up the edge of the hole and the vehicle sinks in deeper. The high torque exerted by the motors also discharges the battery at a high rate, which reduces the capacity more rapidly than were the rate slower. The result may unfortunately be that the battery becomes discharged to such a low value that it is necessary to have the vehicle towed to a charging station. This costs money and interferes with the delivery schedule. But perhaps more important still, the sight of an electric being towed by another electric or a gasoline vehicle creates a very undesirable impression before the public and amongst prospective purchasers particularly.

The electric vehicle is better able to climb out of difficulties than is the gasoline vehicle. The former exerts torque gradually and powerfully, yet smoothly whereas the gasoline engine jerks the vehicle partly out of the hole, straining the clutch and gear mechanisms in doing so; possibly the engine stalls and the vehicle falls back into the hole. The only thing is that the battery of the electric, while doing its work, may do it at too great a sacrifice in that the battery discharges itself. Under all conditions the electric will better the performance of the gasoline vehicle in the way of higher torque, more smoothly applied and longer sustained, but it accomplishes it by sacrificing battery capacity. It is extremely important therefore to employ every available means at one's disposal for economizing battery effort, that is to say, to not discharge the battery recklessly.

By the use during the next five or six months of anti-skid devices, of which there are numerous forms on the market, the electric vehicle can in the majority of cases keep itself out of trouble and economize its battery capacity. The smooth tires of the electric so efficient for every-day running are not conducive to efficient climbing out of mud holes and ruts such as may at any time be encountered unexpectedly. Surely it would be the wise thing therefore for every owner of an electric to equip each vehicle with some device for negotiating bad roads and similar difficulties. These anti-skid devices should not be installed on the tires until they are needed. A length of thick rope or chain that may be easily and quickly applied to the rubber tire when the need arises will save many a delay and much useless battery discharge and many needless home-comings on the crawl.

EFFECT OF COLD UPON BATTERY PERFORMANCE

Every driver of an electric vehicle is appreciative of the fact that for a given charge of the battery the traveling distance is less in winter than in summer, and the colder the day the greater the difference. The ampere-hours used per mile may be greater in winter than in summer because of the condition of the roadway. Even though the ampere-hour meter indicates that a considerable portion of the input remains undischarged the driver knows on a cold day he will only reach home at reduced speed, though his meter tells him his battery is not nearly discharged. The meter indicates the capacity remaining in the battery, but it is not available. In other words, the capacity of a battery is reduced at lower temperatures, and the greater the reduction in temperature the greater the reduction in battery capacity. It is not an irreparable loss, however, since when the temperature rises, the capacity not available before again becomes available. This is one very real objection to the storage battery.

During cold weather the roads are usually bad, thus requiring increased ampere-hours from the battery per mile. The cold temperatures also increase the journal friction of the vehicle, again requiring greater energy consumption per mile. Added to these is the fact that the battery is unable to give up as much of its charge as it can at higher temperatures. It is the loss of battery capacity due to cold weather that is chiefly answerable for electrics having to be hauled to charging stations during the winter or else for their having to creep to their garages at a snail's pace.

COMPARISON OF LEAD AND EDISON BATTERIES

The decrease of available capacity with decreasing temperatures is greater with the Edison battery than with the lead battery. In both cases the condition of the plates and electrolyte and rates of discharge effect the rate of decrease of capacity. In the case of the lead battery the decrease is gradual and rather steady from 60 degrees Fahrenheit down, being about 0.7 to 1.5 per cent loss of capacity for each degree drop in temperature of electrolyte. On the other hand, the Edison battery has what is called a critical temperature, which is around 40 degrees Fahrenheit; this means that while the capacity decrease is gradual between 60 and 40 degrees, after the latter temperature is reached the drop in capacity is rapid. This is a very real disadvantage of the Edison or nickel battery because, whereas with the lead cell the driver may notice that for a definite position of the controller he is traveling more slowly than normally, thus indicating probably that his battery is running down (voltmeter readings give the same information), with the Edison cells he may make the discovery when it is too late.

Usually a driver is too preoccupied with other matters to worry about the condition of his battery as indicated by volt-ampere readings, or speed. The use of an indicating thermometer mounted upon the dashboard would, however, show him when the cold air was likely to affect his battery, though here the chief difficulty and cause of uncertainty would be in obtaining a cell that was typical of all the cells.

REDUCING EFFECT OF COLD UPON BATTERY CAPACITY

The large increase in number of electric vehicles in the larger cities, likewise their use in more numerous fields of endeavor, has enabled electric charging stations to grow up in greater numbers, thus at once removing one of the greatest deterrents to the more universal use of the electric vehicle, and electric commercial truck especially. The ability to charge a battery during the day, for example, during the noonday meal, by giving it a short-time boost charge at a high rate, increases the permissible mileage very materially and improves the condition of the battery. The boost charge will do much to remove the fear amongst drivers of a really cold day and a long route, for it not only charges the battery but also heats up the electrolyte, thus making available some of that capacity not otherwise get-at-able, as already pointed out.

But, although charging stations may be conveniently and judiciously scattered in numerous locations, ready to help out the frozen battery, the only true and proper solution to modify the present objectionable limitations imposed by low temperatures appears to be to make the battery immune from cold. Effort will be made to show the manner in which this may be largely accomplished.

As decreased capacity with decreasing temperature is characteristic of both lead and nickel batteries, and as at the present time there appears no likelihood of a new battery making its appearance that is otherwise affected, attention may be most usefully concentrated upon making the battery immune from cold by modifying conditions external to the battery rather than attempting to change the battery itself. There are two ways of doing this, either of which may be used singly or together. It is the writer's opinion that the day will come when the former of these will be used invariably, the wonder being that it has not been done universally before, for all types of batteries; and when the latter will be done in any case with Edison batteries during the winter months.

One way to prevent these troubles very largely is to install the battery in a box having characteristics somewhat those of a Thermos bottle. To the writer's knowledge all electric vehicles, except one which uses a wooden cover, use steel boxes or coverings to house the battery. Moreover, ample space is permitted under or above and at the sides of these cases for the free circulation of air; in fact, when the vehicles are moving at full speed the ventilation through many of these battery boxes may be likened to forced draft.

Circulation of air around a battery is very desirable while the battery is on charge because hydrogen gas is evolved, and this when mixed with air forms an explosive mixture when in the proportion of about 92 parts air to 8 parts hydrogen. But danger from this cause can be prevented by keeping the battery box open while the battery is on charge, and by keeping lighted matches and other open flames away from the batteries. Moreover it is a good practice to have the charging battery exposed, as this tends to prevent forgetting that it is on charge, thus reducing the possibility of damage by overcharge. In the summer and where the air is dry, circulation of air around a battery is not objectionable. However, sulphuric acid is hygroscopic, and thus where fumes from the electro-

*Electrical Review.

lyte settle upon the woodwork of the vehicle and battery box, corrosion may soon work havoc with the interior of the battery box and adjacent parts if moisture from the air enters.

When cold weather comes the circulation of air through the battery box is extremely objectionable, especially when it circulates with appreciable velocity, coming in through vents and openings such as invariably exist. The cold air reduces the temperature of the battery whether it is working or not, although somewhat less when the battery is discharging, as heat is formed during the reaction. Vents and openings in battery boxes should therefore be closed, except perhaps one gas vent in a sheltered location out of direct force of the draft with the vehicle in motion, otherwise the cold incoming air will reduce the available capacity of the battery.

But this is not the only way in which the cold weather affects a battery. On discharge the battery evolves heat. Some of this is carried away through the vents in the battery box. Part is dissipated through the steel coverings of the battery box. It is a matter of wonderment to the writer that battery boxes are not all of them lined with some form of acid-resisting, heat-insulating, non-absorptive material, with only one vent for the escape of gas. The heat given off by the battery would then remain to keep the internal temperature of the battery box around that required, namely, not below 60 degrees, thus making available the full capacity of the battery. Why not make every battery box an imitation Thermos bottle? Why not do something that can be done so easily, so quickly and so inexpensively, when the results are so far-reaching, in that they may prevent stalling, permit better time of travel during cold weather by making the battery less susceptible to cold, and save the electric ridicule from its rivals?

But why not go still further in climates where the temperature is really low, and more especially where Edison batteries are in use. Make the battery box somewhat like a Thermos bottle, and further install a small electric heater, of about 100 watts, energized from the battery and controlled for constant temperature between perhaps 70 and 45 degrees by means of a thermostat. An Edison battery has about 100 per cent capacity at 80 degrees; 98 at 45, and about 40 per cent at 35, hence if the heater is able to maintain internal temperatures above 45 degrees, a vehicle so equipped will be immune from the effects of cold.

The lead battery is more susceptible to cold than the Edison battery between 80 and 45 degrees Fahrenheit, although its capacity drops gradually instead of suddenly, as does the Edison battery. For example, the lead battery has a capacity of say 105 per cent at 80 degrees, 100 at 70, 95 at 60, 88 at 50, and 80 at 40.

The use of high heat insulation has the advantage over the arrangement employing special heating elements in that it requires no energy from the battery except what otherwise would be wasted, namely, natural warmth. Further, the heating unit would receive its energy from the battery, thus reducing its capacity. However, if 40 per cent of the capacity of a battery may be made available for useful work for the expenditure of but a fraction of this amount, is it not well worth while, for what is the value of that capacity if unavailable?

It is a matter of surprise to the writer that the manufacturers of electric vehicles, and the central-station companies that have done such admirable, untiring and conscientious work in pushing the electric vehicle to the fore should allow the limitations imposed by cold weather upon the storage batteries to exist when they may be so readily overcome.

The manufacturers get together, the central-station companies get together and tell what they are doing in cutting costs and improving apparatus. Will not some of the electric vehicle users get into print, too, and tell of what they have done, what results obtained in the way of bettering performance, reducing maintenance costs and increasing the mileage per unit of cost? The user is, ultimately, the one who must be satisfied. Many users can help other users, likewise the manufacturers who learn only by the experience and co-operation of their customers. It behooves all of us to leave no stone unturned in the endeavor to make the electric as efficient, as reliable and widely applicable as possible. It is only through co-operation that this can be accomplished quickest and most efficiently.

Measurement of Screw Threads

In a paper read before the Liverpool Engineering Society, Mr. Arthur Brooker described a number of devices for measuring the elements of screw threads, including the microscope micrometer, the floating micrometer, optical projection apparatus, and a mechanical arrangement for measuring pitch, designed by the National Physical Laboratory, and using a beam of light as an auxiliary.

He remarked that by his engineering work Whitworth, who suggested his standard form of screw thread in 1841, had a marked effect on British engineering practice, because he not only set higher standards, but provided the means for attaining thereto, and 40 or 50 years ago this country held the lead in the production of accurate work and of apparatus for testing and measuring it. But three years ago we had, except in a few special cases, fallen to a comparatively low position. Other countries, with the aid of some of our skilled workmen, had taken full advantage of Whitworth's work, and the conditions in those countries were such that their manufacturers had opportunities for turning out large quantities of repetition work, so that they could afford to provide special equipment and appliances, and could continually aim at improvement while continually making the same article. In this country the reverse was the case, and the ordinary manufacturer rarely, if ever, had opportunities for producing large quantities of any one article. Only a few firms, highly specialized on account of the nature of their work, paid any attention to accurate measurements and interchangeability; there were few machines in this country capable of cutting an accurate screw thread, and no apparatus available to the ordinary manufacturer for precisely measuring the result. In 1915, when the ordinary British manufacturer got his first chance of manufacturing in large quantities, and of working in conjunction with his brother manufacturers instead of in competition with them, the want of knowledge as regards standards and methods of producing interchangeable parts, particularly screw threads, quickly became evident. Aided by the skilled workmen the manufacturer seized the opportunity and the manufacture of screw threads in this country is now on a wonderfully improved footing as compared with the early part of 1915, although much remains to be done.

It has been proved on a large scale that the ability to measure and work to a ten-thousandth of an inch or less on screw threads, or to a quarter of a degree of angle or less, is one of the best means of saving money, and therefore of increasing profits, when manufacturing in large quantities. Such limits are only occasionally demanded on the actual work, but they are necessary for master gauges, and the measuring apparatus cannot be too well made nor its use too closely studied. A marked improvement in the quality of the work in any factory can be observed when any section of it attains the high standard needed for the production and checking of master gauges or similar work. Were this country in a position to produce the whole of the measuring apparatus required in its workshops, the experienced skilled workmen and good machines which would be called into existence and supported would be of the utmost value in many other directions. Highly efficient measuring apparatus is too often used solely for discovering when work has not been sufficiently well done; it would be better if more of such apparatus were used during the actual production of work, thus assisting the workman in avoiding errors.

In deciding on a standard form of thread for interchangeable screws required in large quantities, the screw itself should receive only secondary consideration, and the object should be to design a thread of such a form that tools, taps, dies and gauges, particularly hardened gauges, could be readily made and have the maximum life, because tools and gauges after a certain point are almost the sole factors in determining output. It is easier, for example, to make tools to an angle of 60 degrees than to one of 55 degrees, because the former is a natural angle. In most workshops the formation of the correct crest and root on a Whitworth thread is found to be a most difficult operation, and great irritation is caused because these elements are recognized as of secondary importance, though under existing conditions they cannot be treated as such.

For screws required in large quantities we shall at some later date probably change to a thread based on metric measurements, with an angle of 60 degrees, a simple form of crest and root, and a moderate amount of clearance between those elements; but the author expressed the hope that, when any such change is contemplated, the casting vote will be given to the producer of dies, taps, chasers, and hardened gauges. In the meantime screw gauges are generally used soft, with consequent trouble due to rapid wear, and perhaps the information most needed at the moment is on the best methods of hardening screw gauges without distortion and the best method of directly measuring the elements of a female thread.—*Engineering Supplement, London Times.*

The Positive Nucleus of the Atom

AMONG other qualities, the Rutherford atomic theory furnishes the method for determining the total mass m^e of electromagnetic material, since with a sphere of radius r and electric charge Q we obtain—$Lm^e = 2Q^2/3c^2a$. In consequence the mass of the positive nucleus of the atom can be determined when the other quantities are substituted in this equation. A further conclusion to be derived from the above expression is a relationship between the atomic weights of different atoms and the radii of their nuclei, and, since the volumes of the nuclei are directly as the third power of the atomic weights, the density of the positive electricity in the nuclei is therefore inversely proportional to the third power of the atomic weights. The latter conclusion appears to be so improbable that the author sets forth in the present paper his proposals for avoiding the above difficulty. He assumes that in a similar way to negative electrons there are individual positive charges on quanta elements of fixed radii which are appropriately chosen so that in connection with the above formula the value of the mass of the hydrogen atom follows. The radius of such a positive electron must in consequence be about 1,800 times smaller than that of a negative electron. A new difficulty has now to be solved with regard to the nature of the forces between the positive electrons in the nucleus. A third difficulty arises out of Rutherford's hypothesis, in that the charge of the positive nucleus in nowise amounts to so many positive quanta as would correspond to the atomic weight of the element concerned, but only to about half that number. The author after discussing these difficulties puts forth a hypothesis for their removal as follows: Let the atomic weight of a particular element be r; the nucleus, however, behaves as if it contained only s positive quanta, which number s, according to Rutherford, is only about $\frac{1}{2}r$, although the assumption may nevertheless be made that the atomic nucleus may be composed of r positive electrons whose mass must be r times as great as m_H, the mass of the hydrogen atom, and equal to the product of m_H and the atomic weight. The total mass of the negative electricity in the atom must also equal r quanta elements, and the remaining $(r—s)$ negative elements should therefore serve to bring about the union of the r positive electrons to a single nucleus, which would then possess a charge of r positive and $(r—s)$ negative quanta. It would therefore act with a positive charge of s quanta and at the same time possess the mass $r.m_H$. About this nucleus the s mobile negative electrons would describe definite orbits in the sense of Bohr's theory. The author shows that on this hypothesis a simple interpretation of the Moseley formula for the K_a line of the Röntgen spectrum becomes possible by the transition of a negative electron from a triple quanta to a double quanta orbit. Similarly the L_a line may be explained. Finally the nature of the union of the positive electrons by negative electricity is examined in detail.—Note in Science Abstracts on an article by A. HAAS in *Phys. Zeits.*

Fundamental Properties of Pigments and Size of Grain

THE paper deals with color (see preceding Abs.), covering power, and effectiveness. Covering power is defined as the area in cm.² of the surface which 1 gram of the pigment will cover so as to make the underlying surface invisible. Covering power depends upon diffusion and refraction of the incident light; a dark coating of aniline may hide the color underneath, without having covering power in the proper sense. The effectiveness (*Ausgiebigkeit*) concerns the predominance of a pigment, and is measured by the number of grams of white pigment with which 1 gram of the pigment in question must be mixed to make the color vanish. Prussian blue has the effectiveness 10,000, permanent green only 100. Both the definitions given depend upon the eye and experience of the observer, but they are simpler than others. The grain size influences the three variables strongly. Iron oxide may be bright red to dark violet; the color and the grain size change on heating, the coarse grains being the darker, while cobalt enamel loses its color when ground fine, brightness and tone changing at the same time. Transparent crystals have no covering power, but gain it on being crushed, to lose it again when the disintegration becomes too fine, of the order of light-waves. The efficiency generally increases on increasing subdivision, and there seems to be no max. limit in this case; some solutions (in molecular subdivision) are most effective; this, however, may only be correct for pigments of considerable absorptive power.—Note in Science Abstracts on an article by W. OSTWALD in *Kolloid Zeits.*

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Shaker screens, by means of which the coal is graded according to size as it passes along the line

From the screens the coal goes to the loader booms, which convey it to cars on the track below

Scenes at the Coal Mines and Some Transportation Problems

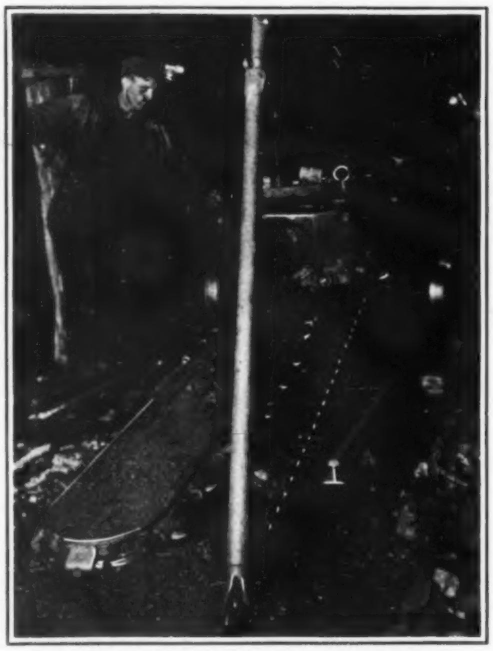
THE coal famine has been so widespread, and so serious, that the accompanying illustrations showing some of the modern methods for the rapid handling of the product at the mine will undoubtedly be of interest. These pictures, with their titles, explain themselves sufficiently for ordinary purposes; but what the public is particularly interested in is the reason for the shortage at a time when fuel was so vitally necessary, both to the individual and the nation.

The cause of the shortage is difficult to determine, and undoubtedly is due to a combination of circumstances that culminated in the present conditions, precipitated by an unusually long period of extremely low temperature. As to the actual supply of coal on hand, or immediately available at the mines, reports are extremely contradictory; but apparently there was no such shortage at the mines as to account for the universal dearth of fuel throughout the country. It would seem, therefore, that the blame can be placed primarily on our methods of distribution and system of transportation.

It is an axiom in railway management that the limiting factor in the efficiency of freight handling is the terminal facilities; for it matters little how many cars and locomotives a road possesses if it cannot unload and reload its cars promptly. This has been fully recognized for many years, but for some reason, possibly because railroads are managed by financial men who are primarily, and personally, interested in the stock market, there is hardly a road in the country that has ever maintained terminal facilities equal to its necessities. As a result, the railroad freight yards throughout the United States are disastrously congested by millions of tons of freight that cannot be delivered to the consignees; and this, in many localities, accounts to a considerable extent for the present inability of the consumer to obtain necessary supplies of fuel.

These conditions work two ways, for not only is the consignee unable to get delivery of his goods, but the cars containing these goods are held out of service, and are unavailable for transporting fresh supplies. The blame for this feature of the congestion is frequently attributed to the consignee, who fails to remove his goods promptly; but in the end it comes back to the railroad, for, on account of inadequate facilities for delivering, the custom grew up of allowing consignees extremely liberal time for removing their goods, with the result that the consignee took advantage of the situation and used the cars for storage purposes. This condition has been somewhat relieved by reducing the free time allowance, and charging demurrage, but the remedy is apparently inadequate, and far too many cars are still held out of service for unnecessarily long periods.

It is claimed that, at many points, the government is a very serious offender in the delay in removing its goods; and the situation is also complicated and exaggerated by unsystematic shipments by many different departments without regard to their mutual requirements; and in many cases there are obviously unnecessary shipments that tend to overburden the roads. For instance, great quantities of supplies have frequently been shipped half across the country to some department headquarters simply for the purpose of checking; and then shipped back again for distribution and consumption. In this case much time and expense would have been saved, and the railroads relieved, if a representative had been sent to the point of origin to attend to the purely technical formalities. One of the worst features of such shipments is that they are made on "priority" orders, and a single shipment of this kind may entirely disarrange the schedules of several trains.



An electrically operated coal cutting machine

Power is supplied by an extension cable connecting with the railway feed wire. The "cutter bar" or arm, shown in the foreground has cutting teeth or picks set in a chain which cut away the coal as they travel around the "cutter bar" somewhat similar to the action of a band-saw. This makes a horizontal cut or "kerf" at the bottom of the seam of coal.

Many things might be done to relive terminal congestion, one of the most obvious being the more general use of motor trucks; and to enable these to be employed to the best advantage suitable road surface should be provided by the railroads at the trucking tracks, and their approaches. At present the roads in the average freight yard are disgracefully primitive. Besides making the removal of freight much more rapid, the motor truck would do much to relieve congestion at freight tracks and platforms because of the less space they occupy, as compared with horse drawn vehicles. Another improvement, especially at receiving platforms, would be the extended use of the small electrically operated tractors and platform trucks, now so well known. These would reduce the delays of consignees' trucks by from 25 to 40 per cent, to the advantage of all concerned. To make these power platform trucks fully effective however, the platforms themselves should have a smooth concrete surface, instead of the rough planking that ordinarily prevails.

In England large storage warehouses are found at many railway terminals to which goods are qickly transferred, instead of letting them stand in the cars. In these communication between the various floors is had by various descriptions of rapid conveyors, which are largely employed in making deliveries, while the loaded cars are lifted bodily to the desired floors by large elevators, where their contents are discharged with a minimum of handling. Some such system would seem particularly applicable and desirable in large cities, where space is limited and valuable.

As has been stated above, the freight terminals of this country have never been adequate to the needs of prompt and convenient handling of goods, and improvement is by no means keeping pace with increasing demands. With facilities for the rapid handling of goods more work could be done with the same number of cars, properly loaded; and this would seem to be the most economical direction for improvement, especially as more cars, with the present terminal facilities, would only increase the existing congestion.

Recent Work in Photographic Photometry

By Edward S. King

THE recent systematic tests have been reduced and confirm the results found in *Harvard Annals* 59, No. 6.

One aim has been to find the stellar magnitude of the various lamps employed in the tests, using yellow and blue light with view of determining the color index. Previous to this work I measured certain bright stars by the out-of-focus method using a yellow screen and yellow sensitive plates. The 8-inch Draper Telescope was used until is was superseded by the 10-inch Metcalf Triplet. In the reduction a discrepancy was met, which was caused by the interposition of the screen and by the difference in focus for yellow light existing between the two instruments. The means of determining the focus for each instrument was at hand in the plates themselves; by plotting the sizes of the images with respect to the focal settings.

The magnitudes found for these stars were based on *Polaris* having a visual magnitude of 2.12. On comparing these photo-visual values with the visual magnitudes, a difference of 0.12 magnitude was found for stars having spectra of Class A. Since the photographic or blue magnitudes are made to agree with the visual magnitudes for Class A, it seems best to do the same for the photo-visual magnitudes, and accordingly I have corrected my values by 0.12 magnitude. Therefore, we have three values for *Polaris*: Visual 2.12; Photographic 2.69; and Photo-visual 2.00 The photo-visual magnitude is subject to revision. By making the yellow as well as the blue values agree with the visual values for stars of Class A, I make such stars the standard of color.

The lamp for comparison is set at a distance from the telescope and photographed out of focus on the same plate with the stars. The photographic magnitude of the Electric Lamp No. 1 furnished by the Bureau of Standards is about—12 at 1 meter, whereas the photo-visual magnitude is about—15, making a color index of 3. The Argand and Hefner Standards are redder. Another part of the out-of-focus work has been to photograph the planets with both yellow and blue light, which will give the color index of each.—*Popular Astronomy.*

Indian Boats and Their Origin*

During recent years the new ethnology has endeavored to adduce evidence of the spread and penetration of ancient Mediterranean culture by sea along definite trade routes from the Red Sea to India, thence eastwards to the myriad islands of Indonesia and the Pacific, and onwards to the American continent itself. A great diversity of customs and many domestic articles of utility or ornament have been examined to see how far they bear out this hypothesis. In the following notes attention is devoted to an examination of what main types of sea and river craft are found in India at the present day, with a view to seeing what light they shed, if any, upon this theory of a cultural sea-route from west to east.

Journeying southwards from Karachi we find that the fishing-boats and coasters of the Bombay Presidency exhibit distinctly Arab characteristics. There can be no mistaking the great grab bow and the huge lateen-sail. With a score of modifications, from the humble fishing-boat with low and pointed stern to the great castellated poop of the buggalow—the Indian brother of the dhow—they are all based on the same ground plan. With them among small craft are a few outrigger boats, and for river work the usual dug-out or ballam common elsewhere on the West Coast. In Malabar and Travancore we find the larger boats to be more or less copies of the Bombay type, with an overwhelming majority of beautifully made dug-out canoes, often of great size. In spite of the primitive nature of the design—one common to all countries in certain stages of maritime evolution—they are surprisingly effective in the hands of expert crews, but form a poor school for training seamen, and are today probably the same in every detail as they were 2,000 years ago. Only in the one instance of the Travancore snake-boat does one meet a type having peculiar significance. This is a large galley-barge manned by many paddlers, and having as distinctive features a peculiar high-sweeping stern and low, ram-shaped bow, distinctly recalling in a simplified form the lines of Phœnician galleys seen in Assyrian sculptures.

Rounding Cape Comorin we find great diversity of design among the sea-craft of the Gulf of Mannar and Palk Bay. The dug-out of Malabar has been improved out of recognition in the beautiful canoe-boats of the Tinnevelly coast, which have ceased to be slab-sided and are miracles of graceful curves. The design is purely local, the main features being an opening up of the dug-out by spreading the sides by means of wedges, and the addition of ribs and of a deep wash-strake. Alongside of these true boats is a peculiar type of three-log catamaran, with permanently tied logs, wholly different in design from those of the Coromandel coast. Further north, Palk Bay and the head of Gulf of Mannar are notable for the ingenuity shown by fishermen and builders in evolving variations of the outrigger boat, which here runs from a tiny craft holding a couple of men to coasters of fifty tons of most primitive build. Northwards from Point Calimere we lose the outrigger type entirely, and reach the land of the true catamaran, exhibiting manifold variation that bespeaks an ancient and honorable lineage. Primitive though it is, it appears to be the only possible design for every-day use upon an open coast eternally lashed by a dangerous surf. Of the masula boats used for in-shore fishing and as cargo lighters it is enough to say that they are roomy, plank-built boats without ribs or framing, sewn together with coir twine instead of being fastened with nails or bolts; they are built with a view to withstand by their elasticity the shock of violent grounding when running ashore in the surf. Finer boats of this peculiar construction are also found in the Laccadives and in Southwest Ceylon, where grounding on reefs is too common an occurrence to permit of rigid, nail-fastened hulls being used.

The delta of the Godavery furnishes a notable exception to the universality of the catamaran upon the East Coast. In the seaward creeks of this great river a host of peculiar fishing craft, called shoe-dhoneys by Europeans, ply their trade. Their name well describes their appearance—wide and flat forward, with a sharp stem, they narrow greatly aft and have a square stem. The forepart is decked in, and as the aft portion roughly two-thirds of the length, has tumble-home sides, the well is narrow and restricted; it is restricted by a high transverse coaming where it meets the fore-deck. The shoe-dhoney carries a lofty mast and high, narrow square sail. Its origin will be referred to later.

EXOTIC AND INDIGENOUS MODELS

Of the sea-craft thus passed in rapid review the Bombay types are the only ones that approximate to a truly Western design, which, in turn, is most probably based upon Egyptian, Minoan, and Phœnician models, as evidenced by the low bow and unusually high stern common to all. It is possible that the Travancore snake-boat is an even closer link with ancient Phœnician trading days, and if it arose as a local attempt to copy the lines of a Phœnician war galley, it is probably the only direct survival of the influence of ancient Mediterranean boat-building upon Indian designs.

The outrigger is found as a dominant design only in the extreme southeast stretch of coast facing Ceylon; we know it is the distinctive boat-type of that wide-spread Polynesian race that stretches west to Madagascar and eastwards to Easter Island, near the South American coast; till recently it was the chief boat-type of the Maldivians, and there can be no hesitation in saying that it came to Ceylon, and then to South India from the Malay Archipelago, just as Zanzibar received it from Madagascar.

As to the catamaran and the shoe-dhoney, these are undoubtedly of indigenous origin. Of the former we see every stage from the most primitive raft, constructed of five or six short unshaped logs roughly tied together—or, in the case of inland waters, of a few plantain stems skewered together temporarily—to elaborately designed craft, built up on the definite lines of shaped logs, and having numerous and ingenious accessory pieces. The shoe-dhoney of the Godavery creeks is, perhaps, even more distinctively indigenous and localized, for catamarans of a sort are also known on the Brazilian coast (of Portuguese introduction?). It is unique in its build and is specially interesting, as, I believe, I am able to indicate its prototype for the first time in the curious palmyra-palm double dug-outs used on the upper reaches of the same river system. These craft consist of two butt-sections of palms roughly hollowed out on one side and lashed side by side. The butt end, being bulbous, one extremity of each dug-out is wide, whereas the other is narrow and truncated, as being part of the cylindrical stem. One of these dug-outs, copied in planks, and with a keel added below the fore end which corresponds to the bulbous butt, gives precisely the design of the shoe-dhoney. As further proving the inland origin of the latter, we have to note its tall mast and high and narrow square-sail, well adapted to top the low banks of river and creek, but a poor design for sea-going craft.

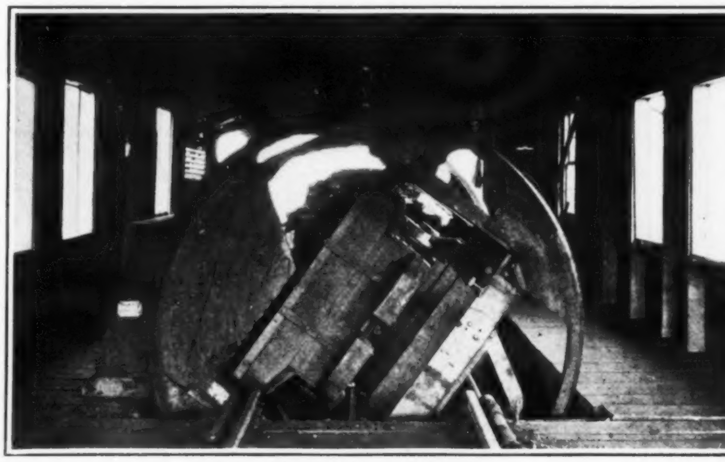
In the general types of river craft seen in India, much less ingenuity is shown in evolving designs for local needs, and correspondingly clearer and more primitive are their relationships to types known in the ancient world. Take the coracles of the Cauvery for instance. Here we have round wicker work boats used largely for ferrying which in their circlar form and hide-covering are undoubtedly of the same lineage as the wicker boat in which the Assyrian merchant used to convey his goods and his ass down the Tigris to the cities of Chaldea, where, after selling his cargo, he dismantled the coracle and loaded the hide upon the ass which was to carry him home by land. Our troops are using this same style of boat on the Tigris even today. Of river craft proper the Ganges, so far as its country craft are concerned, is more akin to the Nile of the Pharaohs than is the present-day condition of the waterway of Egypt. On the Ganges the boats have generally the same high stern and low prow as the lesser craft depicted on the walls of ancient Egyptian tombs and preserved to us in models made for use of the dead, while many of the larger ones possess the same type of quaint fixed steering-paddle characteristic of ancient Egyptian craft. Where this is absent they are fitted with a great balanced rudder in which a considerable portion of the blade is placed forward of the turning axis, exactly as in the fixed quarter-oar, from which it is plain to see it is directly derived.

MODERN INFLUENCES

Of modern European influence upon boat designing scarcely any trace exists except in the isolated case of the Pamban dhoney, a transom or square-sterned lugger used largely in ferrying pilgrims to and from Rameswaram Island in the pre-viaduct days. With the larger deep-sea craft, so far as the East Coast is concerned, the contrary holds good, for European influence has been paramount for the past 200 years, with the result that the shipbuilders of Cocanada, Masulipatam, Negapatam and the northern ports of Ceylon attained a high level of skill; their models were originally the splendid vessels of John Company, refined during the past century by the influence of the clipper design that brought sailing-ship construction as nearly as perfect as it seems possible to attain. Even today, East Coast harbors can often show a collection of wooden brigs and schooners and here and there a barque with high poop and painted imitation gun-ports, that are wholly European, of the early 19th century in appearance. Of Portuguese influence the larger three-masted Maldivian trader seems the only instance, but a most interesting one, as it reproduces for us almost all the outstanding features of the fifteenth century caravels used by Columbus. The Dutch, in spite of their skill in shipbuilding and first-class seamanship, appear to have left no trace on Indian ship designing.

From the foregoing it appears fairly clear that whatever influence Phœnician traders may have exerted upon the coast life of India, no evidence of this is afforded by present-day types of Indian boats save perhaps in the curious Travancore snake-boat; if such influence was ever exerted, it has been submerged or overlaid upon the West Coast by that of the Arabs; the only other foreign influence is a distinctly Polynesian one upon the coast facing Ceylon. All other small coast-boat designs are unmistakably indigenous. Upon inland craft the traces of foreign influence are much more varied; the designs exhibit direct borrowing from the Nile and the rivers of Mesopotamia and shows inland boat builders as more conservative or less ingenious craftsmen than their coast brethren. The general conclusion from a survey of this particular phase of human activity is decidedly against the west to east sea route of culture; it argues much closer relations by way of land traffic with Egypt, Assyria and Babylon, and if the Dravidians be a branch of the Mediterranean race, the evidence of the close approximation of their river boat forms to those of ancient Egypt, taken in conjunction with other facts which cannot be entered upon here, incline me to hazard the hypothesis that many of the resemblances of Dravidian with Minoan customs are not the result of coastal intercourse, but go much deeper and date back to that remote time before the severance of the Dravidian branch from the main stock.

*Reproduced in the *English Mechanics* from the Madras Mail.



View of a rotary dump

A loaded car carrying 2½ tons of coal is run on to the dump, automatically clamped to it and unloaded by one complete revolution of the dump. Incidentally this dump has a capacity of unloading four cars per minute. The coal after being dumped from the car moves along by gravity into the conveyor which leads directly to the screen house. The conveyor is so equipped with retarding devices that the coal is carried to the screen house with a very small minimum of breakage.

Etching Brasses and Bronzes

A few drops of a strong solution of hydrogen peroxide are added to a very dilute solution of chromic acid. The specimen is immersed and kept moving in the solution for a few seconds; it is then removed and washed immediately in running water. The reagent is equally satisfactory for all brasses and bronzes, giving much better results than chromic acid alone.

Fish Food That We Fail to Utilize

A peculiarity of man is the suspicion with which he regards any description of food with which he has not become familiar in his youthful home life, and yet, when it is a question of liquids, he will pour down his throat without hesitation anything that is offered him, from champagne to patent medicines.

Nowhere is this narrow prejudice so persistently displayed as in the matter of food fish, to the detriment of people generally, and, at the present time, that of the nation and its interests, for, although our country is favored by an abundance of fish in an unusually great variety, but a very limited number of them are as yet utilized for food. When the first settlers came to this country they found, among a multitude of fishes, a few which they had become familiar with in their old homes, and these they adopted for their table, entirely ignoring the dozens of other varieties that were equally abundant, and many of which were fully as good, and in many instances better than those utilized. The habits thus formed dictated the market, and ever since that time we, as ostensibly intelligent and progressive people, have limited ourselves to this primitive bill of fare, and allowed unfounded prejudice to deprive us of much of the best of the bounty so easily obtainable.

An example of this narrow prejudice is that of the whiting, or pollock, as it is known to the fishermen on many parts of our coast. In England millions of pounds of this excellent fish are annually brought to the market, where they command a considerably higher price than the cod or haddock; but in this country there is but little demand for them by the public, although in recent years they have been recognized as a delicacy by the fishermen. In a few places the whiting is being canned in limited quantities, but the quantity now being utilized is insignificant in comparison with the available supply, and the greater portion of the fish caught are still thrown away by the fishermen as useless "bait stealers," which is the reputation that they have borne since the early days of the fisheries.

In many cases the reason given for rejecting a certain fish is its appearance; but we are far from being logical in this matter, for nothing is more popular or more sought for than the crab, of unsavory habits and uncouth appearance, nor the lobster, but we refuse to consider the beautiful tilefish, the grayfish and the whiting, which are as attractive in appearance as the universally consumed cod or mackerel.

A summer hotel in Vermont once tried the experiment of placing horn-pout on the menu, only to provoke indignant protests from the guests against such unheard-of and uncivilized food. A few days later the despised fish were again presented under the disguise of "mountain trout," when they met with such enthusiastic favor that several men had to be employed for the rest of the season to catch enough of the fish to satisfy the demands of the discriminating guests. These victims of custom would eat trout, but not catfish.

Practically without exception every fish that swims in salt water, and the same is true of the fresh water varieties, is edible, and this fact the United States Bureau of Fisheries has been endeavoring to impress on the public for a number of years, but progress is slow. Take the case of the tilefish, one of the most attractive that is found on our Atlantic coast. The Bureau has demonstrated that there is an abundant supply, and has carefully indicated to our fishermen where and how to catch it, besides circulating a large amount of information for the instruction of the public in regard to its excellent qualities and how to prepare it; but it is being accepted but slowly—largely, it would seem, because when cooked its meat is a trifle darker than some of the better known fish, like the cod. The only reason for this objection may be traced to the undesirable standards that have been established by purveyors of other classes of food, who teach the public to ask for immature veal that has been whitened by bleeding until its value as food is seriously impaired, and flours, preserved fruits and hundreds of other articles that have been bleached by chemical processes that certainly do not improve their qualities. The general ignorance of quality, and universal dependence on a pretty color in foods, is a serious shortcoming in our people today.

What has been said of our narrowness in selecting our food applies also to our methods of preparing it. We learn half a dozen simple methods of cooking our food, and we adhere to these unendingly, applying them to everything we eat. How many ways do you know of cooking oysters? Possibly four; but the Bureau of Fisheries issues a leaflet that tells a hundred different ways, all simple and easily practical in any household. It tells us 29 different methods of preparing the whiting; 17 for the grayfish; 12 for the tilefish; 33 for the sablefish or black cod, and so on through a long list of different fish that are not at present generally eaten, but which offer attractive possibilities, and which would quickly be welcomed by everybody if only we would overcome the narrow prejudices that go with lack of knowledge.

While the Atlantic coast offers a large variety of "new" fishes, the Pacific waters of our country are, if anything, still more favored by the number of excellent sea foods that it offers us. In our numerous rivers and lakes there is still another source of supplies that has not as yet been developed, among which may be noted the bowfin and the burbot, even the names of which are unfamiliar to most of us, but which would need no second introduction, once they were tried

The Bureau of Fisheries is doing a splendid work in developing our neglected food resources, and it is to be regretted that, in our unsystematic daily scramble, so little attention has been paid to its suggestions and advice; but one thing is certain, and that is that the reports issued by the Bureau are soundly practical and reliable, and are not in any sense armchair opinions or mere laboratory theories. The men who make the suggestions have studied their facts right on the spot, and have arrived at their conclusions from actual practical experience.

Probably the most potent reason for the restricted use of our wonderful supplies of fish lies in the indifference, or opposition, of the wholesale dealer, to whom the fishermen are compelled to dispose of their catch, and who do not care to be troubled with a greater number of kinds of fish than they are obliged to. In many large cities, like New York, these men enjoy a monopoly of the closest kind because of the very limited dock facilities that are permitted the fishermen; and this monopoly is protected by stringent municipal regulations that so favor the occupants of these docks that they can refuse to buy any new varieties of fish and can dictate their own price for what they take, and in this way the public is deprived of the opportunity of availing itself of vast supplies of desirable food. Inspection and the regulation of the sale of fish is desirable, the same as in the case of other food products; but when these regulations are so framed as to work to the disadvantage of the consumer they result in more harm than good. As too frequently operated these regulations are simply cases of political manipulation for the profit of a favored few. If freer markets were afforded the fishermen the public could get more fish, and of the varieties desired, and at materially lower prices. It is generally recognized that the high cost of food is, in many cases, the result of legislation, or obstruction of legislation, promoted by lobbies working in the interests of the "middlemen," and that the surest remedy for the present conditions, in the interest both of the producer and the consuming public, would be a direct line of communication between the two classes. Many plans for accomplishing this have been proposed, but have always been smothered through the influence of those who conduct the present cumbersome and costly machinery of distribution.

Exhaust Steam Waste

Conservation, the keynote these days, looms up morning, noon and night. It is conserve this, that and the other thing, all of which is the proper procedure in every field of labor and endeavor. No doubt about it.

This war will do for the American people what nothing else would have accomplished, and that is, they will be brought to the realization that they can easily do without many things that have been deemed actual necessities. It will also bring out the fact that they have left undone many things that they could have done and that they have allowed waste to go on unchecked just because no one took the initiaive.

For weeks past the newspapers have published articles dealing with the coal shortage and the necessity of saving fuel. Other items have urged the immediate development of water power, to be under Government control, in order to reduce consumption of coal for industrial and commercial purposes. Although more coal was mined in 1917 than in 1916, there is not enough to meet the demand, because of car shortage and other reasons. To overcome this shortage, manufacturers and householders have been and are being urged to economize in fuel in every way.

Has it ever occurred to the Fuel Conservation Commission that the coal consumption of the country could be cut down thousands of tons each year by simply employing a little engineering ability, whereby the steam-plant owner and the householder could be of mutual benefit to one another, and at the same time make a saving in fuel that would be astonishing?

About eighty per cent. of the heat value in every pound of coal consumed in a power-boiler furnace is allowed to go to waste through the engine exhaust to the atmosphere. In all cities there are hundreds of these exhaust pipes discharging to the air, after passing through a steam engine, steam which could be used to advantage in the adjoining buildings that are equipped only with a heating boiler. It would require but slight pipe extensions in most cases to connect these hundreds and thousands of noncondensing engines to the heating systems of adjoining properties, thus supplying their heat requirements with steam that is now going to waste. This would enable thousands of heating boilers to be shut down, and the coal that they burned would be saved and could be delivered to such plants as are in urgent need of it for power purposes.

This journal has and does favor what is termed the isolated-block central station for just the very reasons that now confront this country as a whole—the cheaper production of power, light and heat. This idea has been developed to a limited extent in the larger cities, but not by any means on such an extended line as conditions warrant and the present time demands.

In support of this contention there are steam plants that generate steam for no other purpose than to supply heat to properties not as a by-product, but as a commercial business pure and simple. With the outlay for underground piping and upkeep there is a good profit in carrying on the business, notwithstanding the fact that the demand for steam heat during the summer months is practically cut out, the requirement being mostly for units using steam for power purposes only. We have in mind one large central station in which the reciprocating and turbine units were operated, noncondensing and exhaust steam sold to customers who did away with or had not put in heating boilers.

These instances go to emphasize the fact that exhaust steam is valuable as a heating medium, and there is no dodging the fact that the lack of action to prevent the continued waste of steam is responsible for the unnecessary burning of thousands of tons of coal.

Not only would there be a saving of fuel by the steam consumer and producer getting together on the heating question, but both could make money by so doing. The steam producer would by such an arrangement get his power for practically nothing, and the consumer would obtain his heat cheaper than he could produce it himself. More than that, there would be men released from these isolated heating plants who are needed in other channels of labor.

Why not work along more practical lines, and if tnere are any regulations that stand in the way of utilizing waste steam, as should be done, the Government surely has the power, as a war measure, to set these regulations aside for the common good of all.—*Power.*

On the Time of Fall of a Stone to the Center of the Earth

This problem exercised the minds of geometers of the seventeenth century, *e. g.*, Mersenne estimated the time of fall to the earth's center at six hours; Gassendi, 20 minutes. The 'atter value is the more accurate. If the earth's density is assumed to be throughout of its average value 5.53, then the time of all works out at 1,234 secs. In the present note the author investigates the problem taking into account the variation of density with depth. He adopts the expression for the density variation of $\rho = 10(1 - 0{\cdot}76\, r^2/R^2)$, where r is the distance to the earth's center, and R is the distance to the surface. This function is derived from the ratio of the principal moments of inertia of the globe afforded by the precession of the equinoxes, and gives results in accord with experiments upon the intensity of gravity in mine shafts. [See Abs. 596 (1917).] With these assumptions the duration of fall is found to be 19 mins. 15 secs. The error is thus only 79 secs., when the density is assumed to be constant throughout.—Note in Science Abstracts on an article by M. Sauger in *Comptes Rendus.*

Making Glass Tubes of Precise Dimensions

Making glass tubes of any cross-section, round or polygonal, cylindrical or conical, by fitting a core of the precise dimensions into a glass tube approximately of the desired shape, closing the tube, evacuating it and heating it externally while turning it about its longitudinal axis, until the air pressure has forced the glass uniformly against the core; the core is then withdrawn (no particulars given), and may at once be re-used. The heating may be progressive, and the core, which can be built up of parts, may bear division marks, etc., for the direct production of graduated pipettes, measuring glasses, etc. —Note in Science Abstracts on an article by Lambris in *Zeits. Angen. Chem.*

Acid Bleachers for Photographic Negatives

IN PHOTOGRAPHY one of the most frequent causes of failure is the habit of using solutions of which the composition is doubtful owing to their having been used before. We do not know how much of this or that ingredient has been used up; and, in practice, it may be taken as certain that the best policy in the long run, in all important operations, is to avoid risks, by using fresh solutions wherever possible.

For this reason, the acid bichromate and acid permanganate bleachers possess a great advantage over ferricyanide and bromide, because they are so cheap that there is no temptation to store them and make them serve over and over again. Moreover, they are both to some extent, the permanganate especially, hypo elimninators; so that traces of hypo, which would be fatal in the presence of ferricyanide, may be ignored, particularly when permanganate is used. With bichromate I am uncertain on this point: but have a suspicion that the tone is slightly affected by the presence of hypo.

The bichromate bleacher may vary widely in composition as far as the relative proportions of its ingredients are concerned; but the most efficient and active combination is made by taking forty minims of a five per cent. solution of potassium bichromate, sixty minims of dilute hydrochloric acid (pure hydrochloric acid, sp. g. 1.16, diluted with four times its bulk of water), and adding water to make one ounce. The solution will keep in corked bottles.

With fresh solution bleaching is complete, unless the print is exceptionally deeply printed or strongly alumed, in from one to one and a half minutes, and there is usually a faint image left. Some workers get patchiness, but this I cannot understand; it is a thing which ought never to occur. Failure in bleaching with bichromate is generally due to the yellow stain not being got rid of before sulphiding. By artificial light this stain is easily overlooked; and the result is a yellowness in the final tone, which no subsequent clearing will remove. The stain may be washed out before sulphiding; but this takes time.

The use of an ordinary clearing bath is attended with some risk; but one made as I will describe, which contains hydrochloric acid and not too much sulphite, acts quickly, and may be used with perfect safety. This clearing bath consists of a dram of a twenty-five per cent. solution of sodium sulphite, and a dram and a half of dilute hydrochloric acid, as just mentioned, diluted with water to make four ounces. It should be noted that if a clearing bath containing bisulphite or metabisulphite, or alum, is used, it is necessary to add a certain proportion of common salt to safeguard the image.

The clearing solution just described may be kept in a concentrated form, say four times the strength given above, and then diluted as required. It takes from one to two minutes at most, and should the action not be complete in this time, it may be taken as certain that the clearing bath is used up. It is efficient only so long as it smells distinctly of sulphurous acid. Old solution should not be strengthened or returned to the stock, but thrown away.

After clearing, the prints only require rinsing in about three changes of water, occupying about one minute, before sulphiding. The sulphide solution should be fresh, and of a strength of about two grains to the ounce. To make sure, it is just as well to finish with a second bath of fresh sulphide. The tone is exactly the same as if we used ferricyanide.

The only objection to be raised to bichromate is its poisonous action on the skin; but if prints are bleached singly there is no need to bring the solution in contact with the fingers, so that this objection has no force.

Coming to acid permanganate, an efficient and simple formula is one which can be made up as required from two stock solutions: (A) A solution of forty grains of potassium permanganate in water to make one pint, and (B) pure hydrochloric acid diluted as described above. These solutions keep indefinitely, and the bleacher is made by taking a dram of A, from fifty to sixty minims of B, and diluting the mixture to make one ounce.

Bleaching with this takes about one and a half minutes, and a very slight image, if any, is left. The very slight pink stain may be disregarded, and after a rinse in, say, three changes of water, occupying about one minute, the prints may be sulphided direct. In order, however, that the best tone and the purest whites may be ensured, it is necessary, after the sulphide solution has been washed out, to pass the prints through the clearing bath as used for bichromate.

The only objection to permanganate is that the mixed solution will not keep, and that, if bleaching is prolonged, it may become muddy in use. Should this occur, however, no harm is done. All that is necessary is to add a little more stock solution A and continue the bleaching. There will be perhaps more stain, but that is very easily removed in the final clearing bath after sulphiding.

Recently, however, the writer has worked out an acid permanganate which does not suffer from these disabilities, whilst it is quite as active and efficient as the mixture of permanganate and hydrochloric acid. This is also made up from two stock solutions: (A) forty grains of potassium permanganate in twenty ounces of water, as just described, and (B) two ounces of common salt, and half a fluid ounce of "syrupy phosphoric acid 66%, sp. g. 1.5," with water to make twenty ounces.

It is essential that the salt be free from added farina, which is present in some fancy table salts. A salt which yields a clear solution in cold water will be satisfactory.

The working mixture consists of one dram of A and four drams of B, with water to make one ounce This quantity is sufficient for a print of about 30 square inches or less, which works out at four ounces of solution for a 12 x 10 in. Should this prove insufficient, it is only necessary to add to the mixture in the dish a little more stock solution A. The solution does not become muddy, nor does it deposit any sediment on standing. With the addition of more A it may, in fact, be used for several prints in succession, whilst in all other respects it resembles the mixture of permanganate and hydrochloric acid previously described.

Instead of the phosphoric acid we may substitute, along with the salt, potassium bisulphate, sometimes called pyrosulphate, $K_2S_2O_7$, but the phosphoric acid is preferable. If the salt is omitted either mixture may be used instead of the usual acid permanganate as a reducer for negatives.

A solution containing half a grain of permanganate and twenty-four grains of salt to the ounce will act as a bleacher by itself. It takes about double the time of the acid mixture, leaves a considerable image, free, however, from any patchiness, and causes much stain, but this yields readily to the clearing bath as used for bichromate. A most curious thing is that this non-acid permanganate invariably yields a distinctive tone, viz., a pure warm brown. It is most suitable for fairly vigorous prints and strong sunshine effects, particularly in woodland subjects. In close proximity to prints of the usual sulphide tone it tends by daylight rather to yellowness, so that its use is indicated more for special pictorial than for general work.

One other point should be mentioned. In using acid bleachers it is necessary to avoid contact between the liquid and metals or compounds of the heavy metals. A friend of the writer could never succeed with permanganate until it was discovered that he was using dishes painted with bath enamel. All dishes must be acid-proof, or covered with acid-proof varnish. Enamelled iron, glass, porcelain or vulcanite are perfectly safe.

As regards the relative cost, phosphoric acid, being the stronger acid, works out in practice as cheaper than hydrochloric. Bichromate, if used to the point of exhaustion, is probably slightly cheaper than permanganate at present prices, but as the bichromate is unlikely to be anywhere near used up, the cheapest of all is probably phosphoric acid and permanganate, even with permanganate at 10s. per pound, compared with its pre-war price of 9d.—*T. H. Greenall in Photography and Focus.*

The Law of the Inverse Squares

By T. Powell

A RATHER simple method of proof of Newton's law of the inverse squares lies in the Euclidian theorem that the square of the hypothenuse of a right triangle is equal to the sum of the squares of the opposite sides.

A preliminary consideration of the genesis of an electromagnetic field is necessary. An electric current produces electromagnetic lines circumscribing the flow and perpendicular to it. And it has been proven that an electric current is only an elemental electric charge in motion (Milliken, The Electron, p. 72). Then it follows that an elemental electric charge, when at rest, must also produce an electromagnetic field, for it must be an inherent property of the charge and not a property of motion, else every missile would be so surrounded.

We have good reason to believe (Le Bon, Rutherford, J. J. Thompson, and others) that the constituents of matter are elemental electric charges that have been brought to rest. If these several premises are justified we are forced to the conclusion that the negative corpuscles and positive particles, constituents of matter, propagate electromagnetic fields though not subject to record in the same way as ordinary electromagnetic fields because of difference in their method of production.

We may visualize the inception of an ordinary electromagnetic field and one produced by the same moving charge after it has been brought to rest. In the one case the charge, moving as a unit, surrounds itself at each advancing point in its line of progression, with a field. In the other we have a charge that is brought to rest where, under the rule of the persistence of force, it must continue to dissipate itself as radiant energy. Each radiant becomes a tube of force progressing outward from the nucleus, each radiant thus taking on the properties of a complete charge in motion. The main difference in the two cases is that in the latter the charge is expending itself in an infinite number of radiants and we might look for the electromagnetic field circumscribing any one of its tubes of force to be so infinitely small as to escape ordinary measuring apparatus.

Consider two such electromagnetic fields, one the result of radiant energy from a negative corpuscle and the other produced by a positive particle. Each particle will have tubes of force radiating in every direction, and, at right angles to the tubes, will be the electromagnetic lines. No matter what the diameter of these electromagnetic vortices, there will be a point at which the loops of the negative particle will just touch the loops of the positive particle. Rather, there will be two such points, one on either side of the line connecting the two particles. All oppositely charged electromagnetic waves between these two points will be in such contact as to permit of fusion(?). All loops beyond these points will not impinge and will have no mutual effect.

Whether or not even those in contact will produce an effect, must be somewhat speculative. Such magnetism as is subject to observation may not be separated into its positive and negative components. If it is an impossibility, once they are united, to separate negative from positive magnetism, it seems a justifiable inference that an intense affinity exists between them—that in a separation fluxing into contact they will have a tendency to unite.

There is another line of reasoning that leads to the same conclusion that the last two impinging loops must so act upon each other as to pull together. If two like energies, meeting at incidence, will perform work, two unlike energies, meeting in reflection, must perform an equal amount of work, under the law of action and reaction.

If there is such a pull at the point of impingement of two loops, the extent of the pull will be determined by the angle through which one acts upon the other. As the pull will be transmitted back to the nuclei—the resultant lying along the line connecting the particles—this angle will be the one existing between the acting loop and a line parallel with the line connecting the particles.

Suppose we wish to start with a unit attraction between the two particles. The angle subtended by one loop and the line parallel with the base will be 45°, for either loop must exert a .5 pull. The angle between the two last impinging loops will thus be 90°. We find that we have, between the two tubes of force and the line connecting the two particles, an equilateral right triangle. And the square of the length of either tube of force, or the distance through which one particle is acting upon the other, is to the square of the distance between the two particles, as $.70711_2$ is to 1_2.

If we wish to increase the attraction between the two particles to more than unity, we must let one loop act upon the other through less than 45°. The angle between the two loops increases proportionately, and the ratio of either side of the triangle to the distance between the particles decreases in exact proportion. So the original ratio remains constant, though inversely. The same is true if we start with an attraction between the particles less than unity. In other words, the ratio of the sides of an equilateral right triangle to the base will vary inversely to the attraction between the particles.

The Euclidian system in which the square of the hypothenuse is equal to the sum of the squares of the opposite sides, is applicable here because we have assumed that lines of force have but a single dimension. Had we evidence that a line of force takes an elliptic course, or a hyperbolic curve, then we should have to alter the gravitational law in those particular cases and admit that, just as the sum of the minor angles of a right triangle is greater than a right angle, or less, in the respective cases, so would the attraction vary by less than the squares of the distance or by more than the squares.

The Collocation of Plasmas Within the Cell—II*

A Survey of a Mechanical Theory of Heredity

By Dr. Louis Legrand

Concluded from Scientific American Supplement No. 2195, Page 64, January 26, 1918

XI.—A SURVEY OF THE INTERPLAY OF PLASMATIC CYLINDERS OR RIBBONS

The interplay of these plasmatic masses is not limited to the planes upon which we have thus far maintained them to sketch their relations and their mode of fixation. They are in reality, complete cylinders or ribbons, of demensions as attenuated as you choose, of these chromosomes which we observe in the field of the microscope. The plasmatic figuration in the three dimensions of space will permit us to explain the mode of transmission of the other chromogene characters.

These cylinders of chromophore plasmas, are neither of homogeneous structure nor of uniform constitution. There is no reason why they should be, since nothing is homogeneous in animated nature, or in the living matter. They are formed of longitudinal bundles or fascicules, which are either regular or irregular, and which were joined together, agglutinated, and fixed long ago, and each of which has a special chromogene value and a volume different from that of the others.

In mice, the laws of dominance furnish us, by reason of specific character, an index of the relative value of each fundamental color, since we know that the yellow J dominates the gray G, which in its turn dominates the black N.

Figure 15, in which the plasmatic ribbons preserve their rectilinear position, offers no fixation except between J M and J F, the determinant fascicules of pure yellow. This, therefore, will be the color of the biotype produced.

This color, by its volumetric importance in the common chromatic fascicules, dominates the gray G. M, G F, which dominates in its turn the slender band of black N M, N F; but we observe immediately that a rotation without obliquity of the axis of the fascicules, will bring, for a proportional number of types, if large numbers are concerned, to the respective volumes of the three colors, a certain number of longitudinal contacts G M, G F, the plasmatic arrangement proper to the pure gray biotype, and a small number of longitudinal contacts N M, N F, the plasmatic arrangement proper to the black biotypes, the rarest of all.

But such a rotation, though correct, must be rare. Most often it will have concomitant twistings, and these in every possible direction. That represented in Fig. 16 is equal on the two cylinders, and is accompanied, as may be expected frequently with such an elastic and plastic substance as living plasma, by a certain degree of sliding, which sliding, in this particular case is effected with the same speed upon the two conjugated cylinders; the contacts and fixation of each chromophore plasma with its homologue operate along the line or the plane J J,' over an extent which represents fairly well the probable respective importance of the yellow, the gray, and the black in the average germinative plasma of the species Mouse. From this combination there will result a yellow mouse with gray and black streaks.

Figure 17 represents a type in which the twisting is probably produced to the same degree and in the same direction as above, but the unequal sliding has determined a certain dragging along the axis of the cylinder; it might produce a total detachment of the plasmas G and N with the yellow biotype; but equally well there might result from it any sort of irregularity of adhesion, leaving the homologous N plasmas in contact, with entire gray wedge the product will be yellow, streaked with black, without any admixture of gray—and also streaked with white, for the adhesion of the bands G and G' to some of the yellow corresponds to no known biotype colorant and results in achromia, *i. e.*, in white, by reciprocal interference of the yellow upon the gray, and the gray upon the yellow.

Figure 18 relates to an animal with black eyes (rather important homologous adhesions of the determinant plasmas M in M M and M F), provided with three fundamental colors, yellow, gray, black, all adherent by couples, and pretty extensive, since the obliquity of the plasmatic bands is not very marked.

As there is not any longitudinal separation causing the chromogenic plasma to replace, conformably to any area, a chromogenic segment detached from its homologue, these achromic plasmas X M, X F, although adjacent would not have to exert their power of chromatic interference.

This type utilizes or reveals the following determinants, C, M, J, G, N, P; A and U are excluded as soon as there is a twisting of the chromophore cylinders or ribbons which occasion coincidences more or less great of several chromogenic areas: there can be here neither albinism nor uniformity of fur-color as long as there is a twisting without slipping of the composite ribbon of chromophore plasmas.

Every important slipping, with or without twisting, may evidently entail albinism, when the homologous chromogenic areas have no longer any point of contact between them; albinism may also be a result of the rectilinear facing without slipping or twisting, of two non-homologous chromogenic areas of yellow opposite gray or gray opposite black, or inversely. Therefore, it may result from unequal rotations of each of the plasmatic cylinders around its respective longitudinal axis.

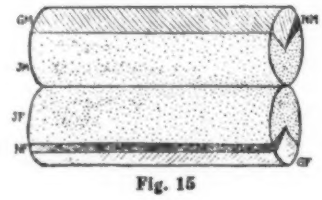


Fig. 15

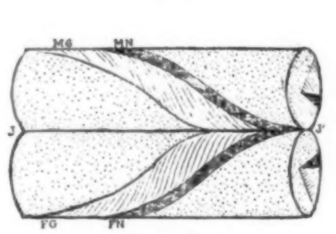


Fig. 16

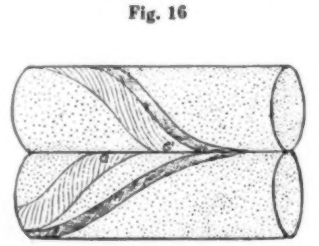


Fig. 17

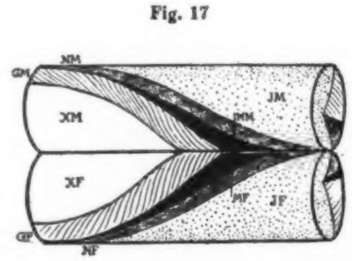


Fig. 18

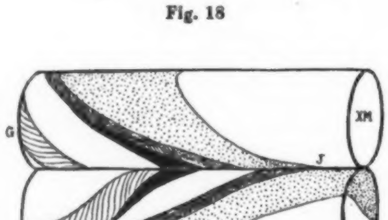


Fig. 19

In this last diagram, Fig. 18, we perceive more and more clearly the possible irregularities of these plasmatic malaxations, with the consequences they involve for the heredity of characters. We are not concerned with rigid crystals, but with semi-fluid substances, such as living plasmas appear to us in every degree of enlargement. Nothing is strictly geometric in a living organism. How could plastic and malleable substances be so?

In the complete plasmatic type of Fig. 19, there has been an inverse slipping of the two cylinders, with irregular adhesions and retardatory facings of the yellow with the non-chromogenic plasmas; in the same way the gays have become displaced, and are no longer in contact with one another anywhere; they are subjected to a complete interference; in the same way the black band is detached from its homologue. However, the plasmas of the choroidal pigments have remained facing each other exactly, and will again give black eyes. It is not a case, therefore, of a true albino; and all the more since in J a light yellow fascicule of the superior ribbon is again mixed with an inferior yellow fascicule. A very light colored coat; a few yellow streaks on the domi ant white, pigmented eyes.

We can rediscover in this figure all the determinants which the biometricians have made known to us, except U, which is exclusive of P. We find here C, J, G, N, M; G, N are present though inoperative.

A is exclusive of C; E is exclusive of M. A, E, V, if not abstractions, are at least states and not substances, since they correspond to a particular type of fixation of the chromogenic plasmas and not of the special plasmas.

Thus all the determinants predicted by the theory have been passed in review and inserted in the various diagrams, of which the last, the most complicated and the most irregular, is also the most evocative of plasmatic masses which are not molecular or molar, but of the same order as ordinary microscopic details. We have chosen because of its difficulty, and by way of a touchstone of the theory, the example everywhere cited, because of the facility with which it can be recognized and measured, of the color of the fur of mice. But all heritable characters, in both kingdoms of Nature, whether coupled or not, are transmitted according to this mechanism. All the non-fixed human characters, which are so numerous, exhibit analogous plasmatic arrangements, from the color of the hair and the eyes to the features of the face, to the vascular and tissular structures, so tenuous, of the cerebral pallium which are the basis of the mnemonic, musical, mathematical, pictural and linguistic aptitudes, with their nuances, their delicacies, their individual peculiarities.

XII. AN EXAMPLE BELONGING TO THE HUMAN SPECIES: DIAGRAMS OF MIXED BREEDS. REPRESENTATION OF THE PERSISTANCE OF BLACK BLOOD IN A LINE OF WHITES

In the four diagrams, Figs. 20-23, may be followed the progressive dilution of the plasmas belonging to the negro race, in the measure in which three successive generations infuse white blood therein. We recognize here the sex of each scion which becomes a genitor in its turn; we perceive here the unilaterality of the black-white plasmatic mixture, with the decrease in the proportion of the colored plasma, and the "whitening" of the ensemble of the ovule at each intervention of a parent of pure white race.

The amphimixic nucleas block of Fig. 20 will be the origin of a mulatto son. A son since MR+RI+II'>I'R'+R'M. He derives from his mother, a pure negress, the three types of plasmas cross-hatched on the diagram; all the chromatins of these cells will repeat this arrangement and the resultant morphology will be inevitably amphibolic, particularly in what concerns racial characters.

This mulatto has, by a white woman, a quadroon daughter whose formative plasmas are those of Fig. 21.

This scion is a daughter, since RF+FA+AI>RR'+RI'. Her pure white plasmas are of maternal origin, her plasmas of paternal origin are mingled with almost a half of black blood. It is a matter always of plasmatic fascicula or bands capable of increases, of twistings, of slidings, of adhesions, according to the modalities studied above.

From this quadroon, united to a white man, is born an octoroon son (Fig. 22). He derives from his mother a proportion of black blood equal to a quarter of the half of his non-fixed plasmas. The name octoroon, therefore, is very exact. The cross-hatched bands, already quite narrow, will be the cause of the appearance of some very definite negroid features (crinkly hair). Finally from a pure white woman united to this octoroon is born a daughter having 1/16 of black blood, represented here by several very narrow erratic bands in the plasmas of maternal origin. The "whitening" of the line is manifest. The negroid characters will be fugaceous and not very perceptible. For example, the half-moon of the nail will be affected, the last vestige of an ancestral colored impregnation already

*Revue Générale des Sciences.

quite remote. But take care lest certain coincidences of plasmatic ribbons, such as that indicated beyond R′, should bring to this stage and even still later, an unsuspected reinforcement of negroid characters and reveal the most singular atavistic revivals.

XIII. The Hybrids

Since, in hybridization, the male is called on to mingle *some* of the characters of his own species with those of the species of the female, the plasmatic value attributed here to each of the gametes would be incompatible with the existence of hybrids if we stopped at the exclusive specialization which Brooks had imagined for each of them.

But our definition of the spermatozoön, based on its histologic description, is sufficiently elastic to escape this criticism: we have seen that this element carries "what it can," in particular a more or less visible light cytoplasmic substance, besides the remarkable caudal appendage so well developed in many species.

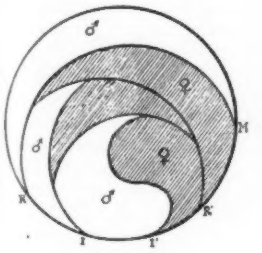


Fig. 20

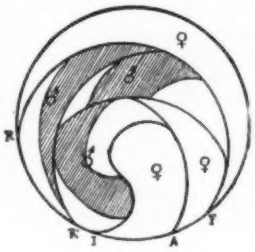


Fig. 21

As the spermatozoön of the ass, in hybridizing the ovule of the mare (*Equus Caballus*) and imbricating its chromatin with that of this ovule, at the same time causes a particle of the specific plasma of the *Equus Asinus* to penetrate the ovule, in the form of an imperceptible cytoplasmic sheath—if not of the tail. What will become of this cytoplasmic fragment? Will it be dissolved in the enormous mass of the female cytoplasm, or, preserving its individuality, apply itself to the surface, in the form of a lenticular cap, on the exterior of the spheroid of non-fixed plasmas? It is, in fact, this last position which will be realized, in accordance with the scheme of the plasmatic collocations.

Biology possesses today extensive enough knowledge on the subject of hybridizations of wild and of domestic animals to enable it to formulate a rule that two forms can not cross unless they belong to the same germs—or exceptionally to the same family, in different genera—the affinity ceasing totally when the systematic difference is very marked.

Therefore, in order for hybridization to occur, it is required, and it is sufficient, that the male element carry with it some plasmas and characters, but not the total plasmas and characters of its species—not that enormous and ancient molecular block by means of which a mammal is provided with hair, a bird with feathers, that indivisible block which does not tolerate that hybridizations should wander into excessive differences, producing winged horses or chimeras, sphinxes or centaurs, providing the Carnivora with horns or the Herbivora with retractile nails—but merely that slender load of plasmas ordinarily fixed which corresponds to the minute difference separating the specific from the generic type, to the *nuance* by which the species *Equus Caballus* differentiates itself in the genus *Equus*, the species *Camis lupus* in the genus *Camis*. These are the most recent sedimentations in the specific block which will be revealed and isolated for an instant, on the occasion of hybridization, in the hybridized ovule of the female species.

The introduction, by the hybridizing spermatozoön, of this plasmatic particle, which, on the already very extended outline of the genus, serves to mold a species, (that of the male), will *defix* from the total specific block of the female the corresponding homodynamic plasmatic cap; and it is these two lenticular segments which, collocating themselves, and overlapping more or less on the exterior of the spheroid of non-fixed plasmas, will contribute to the appearance of the hybrid morphologic type, by the fusion on the generic framework of the traits of the two hybridizing species. (Fig. 24.)

The spermatozoön of the ass, sire of the mule, has no need, therefore, of bringing with it the plasmatic elements of the vertebrata, of the Mammifera, of the Herbrivora, nor even of the Soliped, which are abundant and sufficient in the ovule of the mare; but solely this tiny particle (with respect to the characters it supports) by which an ovule of the jennet differs from an ovule of the mare, all the rest of the plasmas being common to the two species, the horse and the ass.

This generic block, in itself alone, would be capable of reproducing an animal already quite well defined as to shape, dentition, internal organs, limbs, color of hair, something like a composite photograph of the horse, the ass, the zebra, the wild ass, perhaps the *Pliohippus*, the *Miohippus*, rather than a Soliped, an *Equidus*.

XIV. Conclusions

The constructive hypothesis of the present theory are reduced to the minimum: they rest upon an interpretation of the longitudinal segmentation of the chromosomes, "a phenomenon of capital importance, destined to distribute in a strictly equal manner the chromatin of the mother nucleus between the two daughter cells" (Delage); it is necessary to join to this the very exactly symmetrical arrangement of the spindle with its conductor threads imposing a prepared trajectory upon each chromosomic segment, since it is of supreme importance that certain geometic relations once established should not be modified in the course of the transfer of the chromosomes; the regularity of situation of each chromatic loop presenting its summit very exactly towards the axis of the spindle and its outward diverging branches, and its impulse along the directive filamentary system, towards the attractive pole, following a movement which is very symmetrical with relation to its congener; finally the preservation of the connective filaments uniting the twin loops during all the phases of the kinesis. It is true that if the longitudinal dissociation of the chromosomes is very visible and indisputable, the reconstitution of each twin ribbon at the end of the anaphase escapes us, and we must supplement it by the imagination, and believe that the object of all this minutely painstaking preparatory labor cannot be solely that cited above in the phrase of a French savant, and which summarizes the opinion of modern biologists. Above all one has the impression of some delicate and fragile edifice whose transfer, even over a short distance (4 or 5 times its length), demands infinite precautions and a foreseen superfluity of elastic structures (there are generally several achromatic filaments for each transported chromosome).

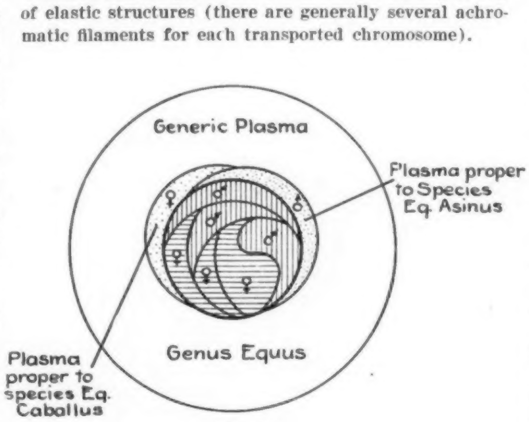


Fig. 24

What matters is, that a given plasmatic segment should be always arranged symmetrically with respect to its homologue, should conserve its orientation with regard to it from the beginning of the protophase, through the metaphase, till the end of the anaphase, and then reconstruct, from the new material provided by nutrition an edifice similar to that of the adjacent sister cell.

Though the first savants who described karyokinesis (Strasburger, Fol, Butschli, Van Beneden, Hertwig), did not fail to ascribe to it, in a general fashion, a relation with the transmission of characters in the soma, the present theory limits this power to the three types of non-fixed plasmas, to the exclusion of the specific plasma, superabundant and ubiquitous in the healthy animal and during growth; it seeks to establish that all the precision of the successive phases of the kinesis *tends to maintain in the daughter cells the arrangement and mode of fixation between them and with the surrounding specific plasma of the various masses of non-fixed plasmas in the position in which they are found after the original amphimixis.*

In the same way, that the nucleus signifies nothing, and can do nothing, isolated from its cytoplasm; likewise that the cytoplasm is nothing but a cadaveric substance as soon as one has succeeded in enucleating it; likewise, that without the specific block, which is their obligatory support, these plasmas of variation are nothing; and it is nothing without them; but it is their interactions, their zones and their modes of contact, of attraction, and of fixation which constitute Life.

The specific Plasma being of maternal origin or of actual digestive synthesis, and the non-fixed plasmas reconstituting themselves approximately in substance and in mode of fixation, in form and in substance, until the cessation of the formative cytodiereses, we perceive that in the fecundated ovule everything is provided for the building up of a new organism.

The terrain of indispensable foundation, ancient and immutable, is the Specific Plasma.

A very profound architectural plan, established *ne varietur* at the origin of each autogenesis and necessarily different from that of its neighbor: this is not an epitome of the finished edifice, *but a small model of construction along which the materials will come to align and coordinate themselves.*

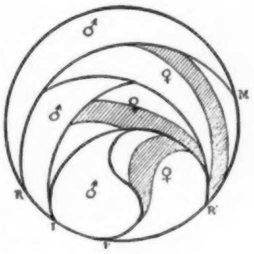


Fig. 22

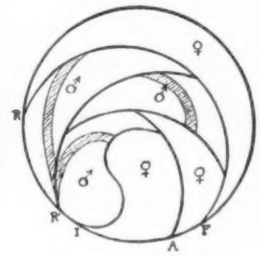


Fig. 23

Finally, the mobile materials to be put to use in order that the edifice may rise, materials drawn in large part from the ground itself.

Thus will every living sexed creature construct itself, whether it be a tree, an animal, or a man.

Apple Scald, Prevented by Ventilation

Apple scald of green and ripe fruit in storage can be entirely and easily prevented by an occasional renewal of the air of the storage room, according to a discovery of the United States Department of Agriculture, just reported by Charles Brooks and J. S. Cooley in the department's Journal of Agricultural Research. The basis of the discovery is the fact that apples are living organisms which breathe and, like other living things, have ventilation requirements which if not met lead to smothering.

Factors in the Production of the Disease

The report states that accumulations of carbon dioxide (carbonic-acid gas) produced by the apples in storage, the lack of air movement in the storage rooms, and the depositing of moisture on the fruit, are all factors that may play a part in the production of scald. The relative importance of these factors is a matter for further investigation. The experiments indicate that high humidities may be maintained in storage without the development of scald, and prove conclusively that an occasional renewal of the air of the storage room will completely prevent the disease. This has been demonstrated in repeated experiments with several varieties of apples. Well-aerated apples remained free from scald, while in all cases poorly aerated ones, handled in the same way from the time they left the tree throughout storage, became badly scalded.

Scalded fruit was found to be more mealy and poorer in flavor than unscalded. Scald, in addition to rendering the fruit unsightly and reducing its market value, rendered the apples extremely susceptible to certain storage rots.

Avoid Smothering the Fruit

Apples were apparently little harmed by several weeks' storage under poorly ventilated conditions if better aeration was provided before the fruit reached a certain critical period in its storage ripening. The maximum length of time that the fruit can remain in poorly ventilated storage without incipient injury, however, has not been determined for many varieties. Final recommendations in regard to the frequency of ventilation, therefore, can not be given as yet, but the investigators state that the fundamental fact that ventilation will prevent the disease has been established, and advise storage men to avoid taking chances of smothering the fruit.

Scald, it was found, increased with an increase in temperature from 41° to 68° F. Higher temperatures were unfavorable to the development of the disease and with certain varieties such as Grimes Golden 32° F. was more favorable to the development of the disease than 41° F.

Investigations of this disease by the department specialists are still going on, but the facts already obtained indicate the necessity of important changes in storage methods.

The Complexity of the Chemical Elements—I*

Electrical Relations, Radio-Active and the Nuclear Theory

By Prof. Frederick Soddy, F.R.S.

THE elements of the chemist are now known to be complex in three different senses. In the first sense the complexity is one that concerns the general nature of matter, and therefore of all the elements in common to a greater or less degree. It follows from the relations between matter and electricity which have developed gradually during the past century as the result of experiments made and theories born within the four walls of this institution. Associated initially with the names of Davy and Faraday, they have only in these days come to full fruition as the result of the very brilliant elucidation of the real nature of electricity by your distinguished professor of physics, Sir Joseph Thomson. Such an advance, developing slowly and fitfully with long intervals of apparent stagnation, needs to be reviewed from generation to generation, disentangled from the undergrowth that obscures it, and its clear conclusions driven home. This complexity of the chemical elements is a consequence of the condition that neither free electricity nor free matter can be studied alone, except in very special phenomena. Our experimental knowledge of matter in quantity is necessarily confined to the complex of matter and electricity, which constitutes the material world. This applies even to the "free" elements of the chemist, which in reality are no more free then than they are in their compounds. The difference is merely that whereas in the latter the elements are combined with other elements, in the so-called free state they are combined with electricity. I shall touch but briefly on this first aspect, as in principle it is now fairly well understood. But its consistent and detailed application to the study of chemical character is still lacking.

The second sense in which the elements, or some of them at least, are known now to be complex has, in sharp contrast to the first, developed suddenly and startlingly from the recognition in radio-active changes of different radio-elements, non-separable by chemical means, now called isotopes. The natural corallary of this is that the chemical element represents rather a type of element, the members of the type being only chemically alike. Alike they are in most of those properties which were studied prior to the last decade of last century, and probably due, as we now think, to the outer shells of the atom—so alike that all the criteria hitherto relied upon by the chemist as being the most infallible and searching would declare them to be identical. The apparent identity goes even deeper into the region reached by X-ray spectrum analysis, which fails to distinguish between them. The difference is found only in that innermost region of all, the nucleus of the atom, of which radio-active phenomena first made us aware.

But, though these phenomena pointed the way, and easily showed to be different what the chemist and spectroscopist would have decided to be identical, they did more. They showed that although the finer and newer criteria relied upon by the chemist in his analysis of matter must of necessity fail in these cases, being ultimately electrical in character, yet the difference should be obvious in that most studied and distinctive characteristic of all—the criterion by which Dalton first distinguished the different kinds of atoms—the atomic weight. Those who have devoted themselves to the exact determination of these weights have now confirmed the difference in two separate cases, which, in the absence of what perhaps they might regard as "preconceived notions," they were unable to discover for themselves. This is the experimental development to which I wish more especially to direct your attention. It indicates that the chemical analysis of matter is, even within its own province, superficial rather than ultimate, and that there are indefinitely more distinct elements than the ninety-two possible types of element accommodated by the present periodic system.

The third sense in which the elements are known to be complex is that which, in the form of philosophical speculations, has come down to us from the ancients, which inspired the labors of the alchemists of the Middle Ages, and, in the form of Prout's hypothesis, has reappeared in scientific chemistry. It is the sense that denies to Nature the right to be complex, and from the earliest times, faith outstripping knowledge, has underlain the belief that all the elements must be built up of the same primordial stuff. The facts of radio-active phenomena have shown that all the radio-elements are indeed made up out of lead and helium, and this has definitely removed the question from the region of pure speculation. We know that helium is certainly a material constituent of the elements in the Proutian sense, and it would be harmless, if probably fruitless, to anticipate the day of fuller knowledge by atom building and unbuilding on paper. Apart altogether from this, however, the existence of isotopes, the generalization concerning the periodic law that has arisen from the study of radio-active change on one hand and the spectra of X-rays on the other, and experiments on the scattering of α particles by matter do give us for the first time a definite conception as to what constitutes the difference between one element and another. We can say how gold would result from lead or mercury, even though the control of the processes necessary to effect the change still eludes us. The nuclear atom proposed by Sir Ernest Rutherford, even though, admittedly, it is only a general and incomplete beginning to a complete theory of atomic structure, enormously simplifies the correlation of a large number of diverse facts. This and what survives of the old electronic theory of matter, in so far as it attempted to explain the periodic law, will therefore be briefly referred to in conclusion.

*Discourse delivered at the Royal Institution and reported in *Nature*.

THE FREE ELEMENT A COMPOUND OF MATTER AND ELECTRICITY

Although Davy and Faraday were the contemporaries of Dalton, it must be remembered that it took chemists fifty years to put the atomic theory on a definite and unassailable basis, so that neither of these investigators had the benefit of the very clear view we hold today. Davy was the originator of the first electrochemical theory of chemical combination, and Faraday's dictum, "The forces of chemical affinity and electricity are one and the same," it is safe to say, inspires all the modern attempts to reduce chemical character to a science in the sense of something that can be measured quantitatively, as well as expressed qualitatively. Faraday's work on the laws of electrolysis and the discovery that followed from it when the atomic theory came to be fully developed, that all monovalent atoms or radicles carry the same charge, that divalent atoms carry twice this charge, and so on, can be regarded today as a simple extension of the law of multiple proportions from compounds between matter and matter to compounds between matter and electricity. Long before the electric charge had been isolated, or the properties of electricity divorced from matter discovered, the same law of multiple proportions which led, without any possibility of escape, to an atomic theory of matter led, as Helmholtz pointed out in his well-known Faraday lecture to the Chemical Society in this theatre in 1881, to an atomic theory of electricity.

The work of Hittorf on the migration of ions, the bold and upsetting conclusion of Arrhenius that in solution many of the compounds hitherto regarded as most stable exist dissociated into ions, the realization that most of the reactions that take place instantaneously and are utilized for the identification of elements in chemical analysis are reactions of ions rather than of the element in question, made very familiar to chemists the enormous difference between the properties of the elements in the charged and in the electrically neutral state.

More slowly appreciated and not yet perhaps sufficiently emphasized was the unparalleled intensity of these charges in comparison with anything that electrical science can show, which can be expressed tritely by the statement that the charge on a milligram of hydrogen ions would raise the potential of the world to 100,000 volts. Or, if we consider another aspect, and calculate how many free hydrogen ions you could force into a bottle without bursting it, provided, of course, that you could do so without discharging the ions, you would find that were the bottle of the strongest steel—the breech of a gun, for example—it would burst, by reason of the mutual repulsion of the charges, before as much was put in as would, in the form of hydrogen gas, show the spectrum of the element in a vacuum tube.

Then came the fundamental advances in our knowledge of the nature of electricity, its isolation as the electron, or atom of negative electricity, the great extension of the conception of ions to explain the conduction of electricity through gases, the theoretical reasoning, due in part to Heaviside, that the electron must possess inertia inversely proportional to the diameter of the sphere on which it is concentrated by reason of the electromagnetic principles discovered by Faraday, leading to the all-embracing monism that all mass may be of electromagnetic origin.

This put the coping-stone to the conclusion that the elements as we apprehend them in ordinary matter are always compounds. In the "free" state they are compounds of the element in multiple atomic proportions with the electron. The ions, which are the real chemically uncombined atoms of matter, can no more exist free in quantity than can the electrons.

The compound may be individual as between the atom and the electron, or it may be statistical, affecting the total number merely of the opposite charges, and the element presumably will be an insulator or conductor of electricity accordingly. Analogously, with compounds, the former condition applies to unionized compounds, such as are met with in the domain of organic chemistry, or ionized, as in the important classes of inorganic compounds, the acids, bases, and salts. Just as the chemist has long regarded the union of hydrogen and chlorine as preceded by the decomposition of the hydrogen and chlorine molecule, so he should now further regard the union itself as a decomposition of the hydrogen atom into the positive ion and the negative electron and a combination of the latter with the chlorine atom.

One of the barriers to the proper understanding and quantitative development of chemical character from this basis is perhaps the conventional idea derived from electrostatics that opposite electric charges neutralize one another. In atomic electricity or chemistry, though the equality of the opposite charges is a necessary condition of existence, there is no such thing as neutralization of the electrically neutral state. Every atom being the seat of distinct opposite charges, intensely localized, the state of electric neutrality can apply only to a remote point outside it, remote in comparison with its own diameter. We are getting back to the conception of Berzelius with some possibility of understanding it, that the atom of hydrogen, for example, may be strongly electro-positive and that of chlorine strongly electro-negative, with regard to one another, and yet each may be electrically neutral in the molar sense. Some day it may be possible to map the electric field surrounding each of the ninety-two possible types of atom over distances comparable with the atomic diameter. Then the study of chemical character would become a science in Kelvin's sense, of something that could be reduced to a number. But the mathematical conceptions and methods of attack used in electrostatics for macroscopic distances are ill-suited for the purposes of chemistry, which will have to develop methods of its own.

We have to face an apparent paradox that the greater the affinity that binds together the material and electrical constituents of the atom, the less is its combining power in the chemical sense. In other words, the chemical affinity is in inverse ratio to the affinity of matter for electrons. The helium atom offers a very simple and instructive case. Helium is non-valent and in the zero family, possessing absolutely no power of chemical combination that can be detected. Yet we know the atom possesses two electrons, for in radioactive change it is expelled without them as the α-particle. The discharge of electricity through it and positive-ray analysis show that the electrons, or certainly one of them, are detachable by electric agencies, although not by chemical agencies. One would expect helium to act as a diad, forming helides analogous to oxides.

Prof. Armstrong for long advocated the view that these inert gases really are endowed with such strong chemical affinities that they are compounds that have never been decomposed. They certainly have such strong affinities for electrons that the atom, the complex of the + ion and electrons, cannot be decomposed chemically. Yet in this case, where the affinity of the matter for the electron is at a maximum, the chemical combining power is absent.

These gases seem to furnish the nearest standard we have to electric neutrality in the atomic sense. The

negative charge of the electrons exactly satisfies the positive charge of the matter, and the atomic complex is chemically, because electrically, neutral. In the case of the electro-positive elements, hydrogen and the alkali metals, one electron more than satisfies the positive charge on the ion, and so long as the equality of opposite charges is not altered the electron tries to get away. In the case of the electro-negative elements, such as the halogens, the negative charge, though equal presumably to the positive, is not sufficient to neutralize the atom. Hence these groups show strong mutual affinity, one having more and the other less negative electricity than would make the system atomically neutral like helium. The electron explains well the merely numerical aspect of valency. But chemical combining power itself seems to require the idea that equal and opposite charges in the atomic sense are only exactly equivalent in the case of the inert gases. None of these ideas are now new but their consistent application to the study of chemical compounds seems curiously to hang fire, as though something were still lacking.

It is so difficult for the chemist consistently to realize that chemical affinity is due to a dissociating as well as to a combining tendency, and is a differential effect. There is only one affinity, probably, and it is the same as that between oppositely charged spheres. But, atomic charges being enormous, and the distances over which they operate in chemical phenomena being minute, this affinity is colossal, even in comparison with chemical standards. What the chemist recognizes as affinity is due to relatively slight differences between the magnitude of the universal tendency of the electron to combine with matter in the case of the different atoms. Over all is the necessary condition that the opposite charges should be equivalent, but this being satisfied, the individual atoms display the tendencies inherent in their structure, some to lose, others to gain electrons, in order, as we believe from Sir Joseph Thomson's teaching, to accommodate the number of electrons in the outermost ring to some definite number. Chemical affinity needs that some shall lose as well as others gain. Chemical union is always preceded by a dissociation. The tendency to combine, only, is specific to any particular atom, but the energy and driving power of combination are due to the universal attraction of the + for the — charge, of matter for the electron.

THE ELECTRICAL THEORY OF MATTER

Another barrier that undoubtedly exists to the better appreciation of the modern point of view, even among those most willing to learn, is the confusion that exists between the earlier and the present attempt to explain the relation between matter and electricity. We know negative electricity apart from matter as the electron. We know positive electricity apart from the electron, the hydrogen ion, and the radiant helium atom, or α-particle of radio-active change, for example, and it *is* matter in the free, or electrically uncombined, condition. Indeed, if you want to find matter free and uncombined, the simple elementary particle of matter in the sense of complexity being discussed, you will go, paradoxically, to what the chemist terms a compound rather than to that which he terms the free element. If this compound is ionized completely it constitutes the nearest approach to matter in the free state. Thus all acids owe their common acidic quality to really free hydrogen, the hydrogen ion, a particle more different from the hydrogen atom than the atom is from the hydrogen molecule. Positive electricity is thus emphatically not the mere absence of electricity, and any electrical theory of matter purporting to explain matter in terms of electricity does so by the palpable sophistry of calling two fundamentally different things by the same name. The dualism remains, whether you speak of matter and electricity, or of positive and negative electricity, and the chemist would do well to stick to his conception of matter until the physicist has got a new name for positive electricity which will not confuse it with the only kind of electricity that can exist apart from matter.

On the other hand, the theory of the electromagnetic origin of mass or inertia is a true monism. It tries to explain consistently two things—the inertia of the electron and the inertia of matter—by the same cause. The inertia of the former being accounted for by the well-known electromagnetic principles of Faraday, by the assumption that the charge on the electron is concentrated into a sphere of appropriate radius, the two thousand-fold greater inertia of the hydrogen ion, for example, can be accounted for by shrinking the sphere to one two-thousandth of the electronic radius.

But the electrical dualism remains completely unexplained. Call the electron E and the hydrogen ion H. The facts are that two E's repel one another with the same force and according to the same law as two H's repel each other, or as an H attracts an E. These very remarkable properties of H and E are not explained by the explanation of the inertia. Are E and H made up of the same stuff or of two different stuffs? We do not know, and certainly have no good reason to assume that matter *minus* its electrons is made of the same thing as the electron. We have still to reckon with two different things.

THE CHEMICAL ELEMENTS NOT NECESSARILY HOMOGENEOUS

I pass now to the second and most novel sense in which the elements, or some of them at least, are complex. In their discovery of new radio-active elements M. and Mme. Curie used radio-activity as a method of chemical analysis precisely as Bunsen and Kirchhoff, and later Sir William Crookes, used spectrum analysis to discover cæsium and rubidium, and thallium. The new method yielded at once, from uranium minerals, three new radio-elements—radium, polonium, and actinium. According to the theory of Sir Ernest Rutherford and myself, these elements are intermediate members in a long sequence of changes of the parent element uranium. In a mineral the various members of the series must co-exist in equilibrium, provided none succeed in escaping from the mineral, in quantities inversely proportional to their respective rates of change, or directly proportional to their periods of average life. Radium changes sufficiently slowly to accumulate in small but ponderable quantity in a uranium mineral, and so it was shown to be a new member of the alkaline-earth family of elements, with atomic weight 226.0, occupying a vacant place in the periodic table. Polonium changes 4,500 times more rapidly, and can only exist to the extent of a few hundredths of a milligram in a ton of uranium mineral. Actinium also, though its life period is still unknown, and very possibly is quite long, is scarce for another reason: that it is not in the main line of disintegration, but in a branch series which claims only a few per cent. of the uranium atoms disintegrating. In spite of this, polonium and actinium have just as much right to be considered new elements probably as radium has. Polonium has great resemblances in chemical character both to bismuth and tellurium, but was separated from the first by Mme. Curie, and from the second by Marckwald. In the position it occupies as the last member of the sulphur group, bismuth and tellurium are its neighbors in the periodic table. Actinium resembles the rare-earth elements, and most closely lanthanum, but an enrichment of the proportion of actinium from lanthanum has been effected by Giesel. The smallness of the quantities alone prevents their complete separation in the form of pure compounds, as was done for radium.

The three gaseous members, the emanations of radium, actinium and thorium, were put in their proper place in the periodic table almost as soon as radium was, for, being chemically inert gases, their characterization was simple. They are the last members of the argon family, and the fact that there are three of about the same atomic weight was probably the first indication, although not clearly appreciated, that more than one chemical element could occupy the same place in the periodic table.

The extension of the three disintegration series proceeded apace, new members were being continually added, but no other new radio-element—new, that is, in possessing a new chemical character—was discovered. The four longest lived to be added, radio-lead, or radium-D, as it is now more precisely termed, and ionium in the uranium series, and mesothorium-I and radiothorium in the thorium series, could not be separated from other constituents always present in the minerals—radium-D from lead, ionium and radiothorium from thorium, and mesothorium-I from radium. An appreciable proportion of the radio-activity of a uranium mineral is due to radium-D and its products, and its separation would have been a valuable technical achievement, but though many attempts have been made, this has never been accomplished, and, we know now, probably never will be.

Seven years ago it was the general opinion in the then comparatively undeveloped knowledge of the chemistry of the radio-elements that there was nothing especially remarkable in this. The chemist is familiar with many pairs or groups of elements the separation of which is laborious and difficult, and the radio-chemist had not then fully appreciated the power of radio-active analysis in detecting a very slight change in the proportions of two elements, one or both of which were radio-active. The case is not at all like that of the rare-earth group of elements, for example, in which the equivalent or atomic weight is used as a guide to the progress of the separation. Here, the total difference in the equivalent of the completely separated elements is only a very small percentage of the equivalent, and the separation must already have proceeded a long way before it can be ascertained.

Human nature plays its part in scientific advances, and the chemist is human like the rest. My own views on the matter developed with some speed, when, in 1910, I came across a new case of this phenomenon. Trying to find out the chemical character of mesothorium-I, which had been kept secret for technical reasons, I found it to have precisely the same chemical character as radium, a discovery which was made in the same year by Marckwald, and actually first published by him. I delayed my publication some months to complete a very careful fractional crystallization of the barium-radium-mesothorium-I chloride separated from thorianite. Although a great number of fractionations were performed, and the radium was enriched, with regard to the barium, several hundred times, the ratio between the radium and mesothorium-I was, within the very small margin of error possible in careful radio-active measurements, not affected by the process. I felt justified in concluding from this case, and its analogy with several other similar cases then known, that radium and mesothorium-I were non-separable by chemical processes, and had a chemical character not merely like, but identical. It followed that some of the common elements might similarly be mixtures of chemically identical elements. In the cases cited the non-separable pairs differ in atomic weight from two to four units. Hence the lack of any regular numerical relationships between the atomic weights would, on this view, follow naturally (Trans. Chem. Soc., 1911, vol. xcix., p. 72). This idea was elaborated in the Chemical Society's Annual Report on Radio-activity for 1910, in the concluding section summing up the position at that time. This was, I think, the beginning of the conception of different elements, identical chemically, which later came to be termed "isotopes," though it is sometimes attributed to K. Fajans, whose valuable contributions to radio-activity had not at that date commenced, and whose first contribution to this subject did not appear until 1913.

In the six or seven years that have elapsed the view has received complete vindication. Really three distinct lines of advance converged to a common conclusion, and, so far as is possible, these may be disentangled. First there has been the exact chemical characterization from the new point of view of every one of the members of the three disintegration series with lives over one minute. Secondly came the sweeping generalizations in the interpretation of the periodic law. Lastly there has been in the first beginnings of our experimental knowledge of atomic structure, which got beyond the electronic constituents and at the material atom itself.

In pursuance of the first, Alexander Fleck, at my request, commenced a careful systematic study of the chemical character of all the radio-elements known, of which our knowledge was lacking or imperfect, to see which were, and which were not, separable from known chemical elements. Seldom can the results of so much long and laborious chemical work be expressed in so few words. Every one that it was possible to examine was found to be chemically identical either with some common element or with another of the new radio-elements. Of the more important characterizations, mesothorium-II was found to be non-separable from actinium, radium-A from polonium, the three B-members and radium-D from lead, the three C-members and radium-E from bismuth, actinum-D and thorium-D from thallium. These results naturally took some time to complete, and became known fairly widely to others working in the subject before they were published, through A. S. Russell, an old student, who was then carrying on his investigations in radio-activity in Manchester. Their interpretation constitutes the second line of advance.

Before that is considered, it may first be said that every case of chemical non-separability put forward has stood the test of time, and all the many skilled workers who have pitted their chemical skill against Nature in this quest have merely confirmed it. The evidence at the present day is too numerous and detailed to recount. It comes from sources, such as in the technical extraction of mesothorium from monazite, where one process is repeated a nearly endless number of times; from trials of a very great variety of methods, as, for example, in the investigations on radium-D and lead by Paneth and von Hevesy; it is drawn from totally new methods, as in the beautiful

proof by the same authors of the electro-chemical identity of these two isotopes; it is at the basis of the use of radio-active elements as indicators for studying the properties of a common element isotopic with them, at concentrations too feeble to be otherwise dealt with; and from large numbers of isolated observations, as well as prolonged systematic researches. One of the finest examples of the latter kind of work, the Austrian researches on ionium, will be dealt with later. The most recent, which appeared last April, is by T. W. Richards and N. F. Hall, who subjected lead from Australian carnotite, containing therefore radium-D, to more than a thousand fractional crystallizations in the form of chloride without appreciably altering the atomic weight or the β activity. So that it may be safely stated that no one who has ever really tested this conclusion now doubts it, and, after all, they alone have a right to an opinion.

This statement of the non-separability by chemical methods of pairs or groups of elements suffers perhaps from being in a negative form. It looks too much like a mere negative result, a failure, but in reality it is one of the most sweeping positive generalizations that could be made. Ionium, we say, is non-separable from thorium, but every chemist knows thorium is readily separated from every other known element. Hence one now knows every detail of the chemistry of the vast majority of these new radio-elements by proxy, even when their life is to be measured in minutes or seconds, as completely as if they were obtainable, like thorium is, by the ton. The difference it makes can only be appreciated by those who have lived through earlier days, when, in some cases, dealing with the separation of radio-constituents from complex minerals, after every chemical separation one took the separated parts to the electroscope to find out where the desired constituent was.

As the evidence accumulated that we had to deal here with something new and fundamental, the question naturally arose whether the spectrum of isotopes would be the same. The spectrum is known, like the chemical character, to be an electronic rather than mass phenomenon, and it was to be expected that the identity should extend to the spectrum. The question has been tested very thoroughly, by A. S. Russell and R. Rossi in this country, and by the Austrian workers at the Radium Institut of Vienna, for ionium and thorium, and by numerous workers for the different isotopes of lead. No certain difference has been found, and it may be concluded that the spectra of isotopes are identical. This identity probably extends to the X-ray spectra, Rutherford and Andrade having shown that the spectrum of the γ-rays of radium-B is identical with the X-ray spectrum of its isotope lead.

THE PERIODIC LAW AND RADIO-ACTIVE CHANGE

The second line of advance interprets the periodic law. It began in 1911 with the observation that the product of an α-ray change always occupied a place in the periodic table two places removed from the parent in the direction of diminishing mass, and that in subsequent changes where α rays are not expelled, the product frequently reverts in chemical character to that of the parent, though its atomic weight is reduced four units by the loss of the α particle, making the passage across the table curiously alternating. Thus the product of radium (Group II.) by an α-ray change is the emanation in the zero group, of ionium (Group IV.) radium, and so on, while in the thorium series thorium (Group IV.) produces by an α-ray change mesothorium-I (Group II.), which in subsequent changes in which no α rays are expelled yields radio-thorium, back in Group IV. again ("Chemistry of the Radio-Elements," p. 29, first edition, 1911). Nothing at that time could be said about β-ray changes. The products were for the most part very short-lived and imperfectly characterized chemically, and several lacunæ still existed in the series, masking the simplicity of the process. But early in 1913 the whole scheme became clear, and was pointed out first by A. S. Russell, in a slightly imperfect form, independently by K. Fajans from electrochemical evidence, and by myself in full knowledge of Fleck's results, still for the most part unpublished, all within the same month of February. It was found that, making the assumption that uranium-X was in reality two successive products giving β rays, a prediction Fajans and Göhring proved to be correct within a month, and a slight alteration in the order at the beginning of the uranium series, every α-ray change produced a shift of place as described, and every β-ray change a shift of one place in the opposite direction. Further, and most significantly, when the successive members of the three disintegration series were put in the places in the table dictated by these two rules, it was found that all the elements occupying the same place were those which had been found to be non-separable by chemical processes from one another, and from the element already occupying that place, if it was occupied, before the discovery of radio-activity. For this reason the term isotope was coined to express an element chemically non-separable from the other, the term signifying "the same place."

So arranged, the three series extended from uranium to thallium, and the ultimate product of each series fell into the place occupied by the element lead. The ultimate products of thorium should, because six α particles are expelled in the process, have an atomic weight twenty-four units less than the parent, or about 208. The main ultimate product of uranium, since eight α particles are expelled in this case, should have the atomic weight 206. The atomic weight of ordinary lead is 207.2, which made it appear very likely that ordinary lead was a mixture of the two isotopes, derived from uranium and thorium. The prediction follows that lead, separated from a thorium mineral, should have an atomic weight about a unit higher, and that separated from uranium minerals about a unit lower, than the atomic weight of common lead, and in each case this has now been satisfactorily established.

THE ATOMIC WEIGHT OF LEAD FROM RADIO-ACTIVE MINERALS

It should be said that Boltwood and also Holmes had, from geological evidence, both decided definitely against its being possible that lead was a product of thorium, because thorium minerals contain too little lead, in proportion to the thorium, to accord with their geological ages; whereas the conclusion that lead was the ultimate product of the uranium series had been thoroughly established by geological evidence, and has been the means, in the hands of skilful investigators, of ascertaining geological ages with a degree of precision not hitherto possible. Fortunately I was not deterred by the *non possumus*, for it looks as if both conclusions are right! An explanation of this paradox will be attempted later. In point of fact, there are exceedingly few thorium minerals that do not contain uranium, and since the rate of change of uranium is about 2.6 times that of thorium, one part of uranium is equal as a lead producer to 2.6 parts of thorium. Thus Ceylon thorianite, one of the richest of thorium minerals, containing 60 to 70 per cent. of ThO_2, may contain 10 to 20, and even 30, per cent. of U_3O_8, and the lead from it may be expected to consist of very similar quantities of the two isotopes, to be, in fact, very similar to ordinary lead. I know of only one mineral which is suitable for this test. It was discovered at the same time as thorianite, and from the same locality, Ceylon thorite, a hydrated silicate containing some 57 per cent. of thorium and 1 per cent. of uranium only. In the original analysis no lead was recorded, but I found it contained 0.4 per cent., which, if it were derived from uranium only, would indicate a very hoary ancestry, comparable, indeed, with the period of average life of uranium itself. On the other hand, if all the lead (1) is of radio-active origin, (2) is stable, and (3) is derived from both constituents as the generalization being discussed indicated, this 0.4 per cent. of lead should consist 95.5 per cent. of the thorium isotope and 4.5 per cent. of the uranium isotope. Thorite thus offered an extremely favorable case for examination.

In preliminary experiments in conjunction with H. Hyman, in which only a gram or less of the lead was available, the atomic weight was found relatively to ordinary lead to be perceptibly higher, and the difference, rather less than ½ per cent., was of the expected order.

I was so fortunate as to secure a lot of 30 kilos of this unique mineral, which was first carefully sorted piece by piece from admixed thorianite and doubtful specimens. From the 20 kilos of first-grade thorite the lead was separated, purified, reduced to metal, and cast *in vacuo* into a cylinder, and its density determined, together with that of a cylinder of common lead similarly purified and prepared. Sir Ernest Rutherford's theory of atomic structure, to be dealt with in the latter part of this discourse, and the whole of our knowledge as to what isotopes were, made it appear probable that their atomic volumes, like their chemical character and spectra, should be identical, and therefore that their density should be proportional to their atomic weight. The thorite lead proved to be 0.26 per cent. denser than the common lead. Taking the figure 207.2 for the atomic weight of common lead, the calculated atomic weight of the specimen should be 207.74.

The two specimens of lead were fractionally distilled *in vacuo*, and a comparison of the atomic weights of the two middle fractions made by a development of one of Stas's methods. The lead was converted into nitrate in a quartz vessel, and then into chloride by a current of hydrogen chloride, in which it was heated at gradually increasing temperature to constant weight. Only single determinations have been done, and they gave the values 207.20 for ordinary lead, and 207.694 for the thorite lead, figures that are in the ratio of 100 to 100.24. This therefore favored the conclusion that the atomic volume of isotopes is constant.

At the request of Mr. Lawson, interned in Austria, and continuing his researches at the Radium Institut under Prof. Stefan Meyer, the first fraction of the distilled thorite lead was sent him, so that the work could be checked. He reports that Prof. Hönigschmid has carried through an atomic weight determination by the silver method, obtaining the value 207.77 ± 0.014 as the mean of eight determinations. Hence the conclusion that the atomic weight of lead derived from thorite is higher than that of common lead has been put beyond reasonable doubt.

[TO BE CONTINUED]

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